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Implications for planning smart parking schemes in Espoo

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Abstract

The Helsinki Metropolitan Area faces a significant urbanisation challenge with the population and number of jobs in the region expected to double by 2050. So that the transport network can cope with the increased pressures that urbanisation brings, there is effort to improve sustainability and efficiency of transport within the region. A dynamic parking scheme may help to stimulate development and encourage a move to more sustainable transport modes.

This research proposed a dynamic parking scheme for the urban area of Leppävaara, in which the tariff changes according to temporal and geographical variables, and investigated how such a scheme may impact travel behaviour for different purposes. The research was composed of four parts, a review of existing literature on the subject, interviews with field experts, an analysis of parking in Leppävaara and a survey to ascertain public opinion of the proposed scheme.

Previous research indicates that parking fees can be politically difficult to implement but that they can be very effective in encouraging more sustainable transportation. Smart parking technologies have shown that enforcement and collection of parking fees can be made easier and cheaper. Field experts admit that parking demands can be a barrier to development and that parking fees are in principle a good idea for reasons of equality and sustainability.

In the study area of Leppävaara, there are about 1.2 residential parking spaces for each car and about 0.25 commercial parking spaces per employee. Taking modal shares into account this would indicate that for residents and employees, there are sufficient amounts of off-street parking spaces, meaning that on-street parking spaces could be used in the main by visitors to Leppävaara.

The survey revealed that the majority are opposed to parking fees although a notable proportion believed a small parking fee to be reasonable. If parking fees were implemented on all parking spaces, many people who visit Leppävaara for shopping purposes would go elsewhere to avoid fees. People visiting Leppävaara for work purposes would not change their behaviour so significantly because the employer would pay for travel expenses. Many visiting for social reasons would change to a different transport mode instead of the car.

A parking control scheme should involve all parking spaces, both private and public, within the urban area. The cooperation required for such a scheme is very challenging however, considering the number of stakeholders and differing interests involved.

Keywords Smart parking, dynamic parking fees, urban transport planning, co-design

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1 Introduction

In Finland, the Helsinki metropolitan region (HMA) faces a significant urbanisation challenge. It is predicted that across the region, the number of jobs and the population will almost double by 2050[1]. In response to the likely challenge this rapid growth will represent to the transport network, the Helsinki Region Transport System Plan 2015 has, amongst other aims, an emphasis on encouraging sustainable forms of transport whilst improving the efficiency of existing transport systems through the use of technology and smart solutions.

Although new rail infrastructure projects have been planned and developed to cope with the some of the anticipated increase in demand on the transport network, it is clear that more innovative and integrated measures are required to maximise the positive and minimise the negative effects of the existing and planned network.

One proposed solution that has attracted headlines around the world is the concept of mobility as a service. This is the idea that a single service provider offers a variety of different means of mobility, including public transport and shared vehicles, as part of one service package. The customer pays a fee which entitles them to use elements of this mobility package accordingly. The City of Helsinki has commissioned further research into the innovation, which proposes the idea of a combined system of transport modes working with communication technology to support every day mobility [2].

It is within this context that in 2015 the City of Espoo, one of four authorities which make up the HMA, published a report into car parking policy and practice within the municipality. An outcome of the report was a series of action points which aim to improve efficiency and equity of parking for the people of Espoo. These action points included the development of a parking charge scheme, promoting smart parking technologies, and the encouragement more efficient, centralised parking areas [3]. In essence the message of the report was that car parking should be seen and operated as a service, rather than as infrastructure which users often take for granted and expect to be provided for free[3].

Amongst these action points, of particular interest in this research is the development of parking charges which has potential to encourage more sustainable forms of transport[4]–[11]. This then, responds to the principle of maximising efficiency found within the Helsinki Region Transport System Plan 2015. Furthermore, the development of communication technology to better inform transport system users of potential charges can form a small part of the mobility as a service concept that is being investigated for the region.

The aim of this research is to investigate the possibilities of a smart parking system for Leppävaara, a major urban area within the growing, polycentric HMA municipality of the City of Espoo.

The structure of the paper is as follows: First, we explore previous relevant research in the theoretical background. In the methodological approach we draw lessons from field experts in a series of interviews and introduce a survey which forms part of the quantitative research. Then, in the practical background we explore the study area in greater detail, looking in particular at the parking situation and transport and accessibility issues. On the basis of this analysis, we propose a simple dynamic parking scheme which will form the basis of our survey. The survey set up is then introduced followed by deeper analysis of results. Finally, there is a discussion of lessons learnt and conclusions.

2 Theoretical background

This chapter broadly reviews the existing literature related to parking and parking controls. Firstly, the aims that parking schemes hope to achieve are examined, and then the different sort of parking control tools available are looked at in closer detail. Finally, there is a brief look at how smart parking technology enables more creative parking control solutions.

2.1 *Parking goals*

To understand a parking control scheme it is necessary to know why it is implemented and what it is trying to achieve. In general, it has been suggested that parking schemes can be used to: support a healthy economic climate, encourage more efficient use of transport and land resources, improve accessibility, enable more equitable distribution of resources, improve the environment, and improve cultural attractiveness [4], [5]. In addition, it is stated elsewhere that parking is also needed to improve traffic flow and safety[12], and that good parking schemes alleviate problems such as driver frustration [6]. The New-Urbanism movement has also pushed forward the use of parking controls as part of a package of measures to improve sustainability, efficiency and reduce reliance on the car, which in turn, it is hoped, will improve visual amenity and encourage higher densities [13]. This list of aims is summarised in Table 1 below. There is then, a quite complex set of goals which are sometimes overlapping and sometimes contradictory. Improved accessibility for example might lead to a better economic climate for an area. On the other hand efforts to use parking controls to reduce traffic for environmental reasons might have negative economic impacts if there are no suitable alternative transport modes available. The next section looks at each of these goals in slightly more detail.

Table 1. Summary of parking goals

Parking goal
Support a healthy economic climate By providing sufficient parking spaces for customers, ensuring turnover of customers, reducing congestion for customers
Encourage more efficient use of transport land and resources By promoting more sustainable transport forms, develop parking more carefully in areas of high value
Improve accessibility By planning parking in conjunction with other transport modes, and through careful design and location of parking areas
Enable equitable distribution of resources By ensuring that different user groups are able to use spaces where they need
Improve the environment By reducing or relocating vehicular traffic
Improve cultural attractiveness Through careful design of parking areas, or by locating parking areas away from sensitive sites.
Improve traffic flow and safety By careful design and location of parking areas and encouraging safer transport modes
Alleviate driver frustration By careful design of parking areas and dispensing information
Improve sustainability and higher housing densities By encouraging different transport modes and reducing parking requirements.

2.1.1 Environmental impact

The argument for using parking controls to improve the environment is fairly simple. Parking spaces attract traffic, and traffic pollutes the air and creates noise[14]. If parking controls can be used to reduce traffic, then air quality and noise pollution will improve too. Another environmental benefit is that parking management may reduce the total paved area of a town or city which, if replaced with landscaping or park land, may assist storm water runoff and reduce the likelihood of flooding[15].

From an economic perspective it has been recognised that the external social costs of road transport include negative impacts on the environment. Therefore some form of Pigouvian taxation should be implemented on road transport to compensate for these negative effects felt by society. A parking scheme can be used, amongst other methods, to collect this taxation [16].

With regard to air pollution however, a localised parking scheme that focuses on just a few streets will do very little to improve the environmental situation if the pollution is spread over a city wide area[4]. More successful results may be achieved on streets that have high traffic volumes, which have caused a known localised air pollution problem. If the parking scheme can disperse the traffic to elsewhere on the transport network then air quality may improve on the street in question.

Of course, in these instances environmental conditions are only improved if the scheme reduces traffic volumes of road based passenger vehicles. It is worth remembering therefore, that some mechanisms to control parking, such as replacing long term parking spaces with short term parking spaces, may in fact increase traffic volumes thereby exacerbating any existing environmental problems[17].

Just one example of a scheme implemented in part, to fight against air pollution problems can be found in San Fransisco. There, a parking control scheme using dynamic parking fees was implemented to reduce cruising for parking in order to improve air quality and congestion problems[18].

Whilst Espoo parking policy does not explicitly say that the purpose of parking controls should be to improve the environment, there is an emphasis on sustainability and encouraging use of public transport and bicycles to reduce car traffic so that vehicular emissions are reduced[3].

2.1.2 Transportation and land use balance

In a dense urban environment, parking spaces take up valuable land. There is an estimated total of 400,000 parking spaces in the municipality of Espoo and 140,000 cars[3]. A large proportion of these spaces are located in the urban centres, where the cost of land is higher and where space is also needed for places of work, shops, and housing. If all of these parking spaces were arranged into one parking area, with each space taking 30m²[19] the car park would measure 11km² in size, and two thirds of these spaces would be empty at any one time.

It is clear then that strategies to encourage more sustainable use of parking would free up land for more profitable uses[7]. Parking demand for different land uses varies over time. For offices and places of work, car parks are closer to capacity during the daytime. But car parks for restaurants and late night shopping are busier during the evening[15]. It would more efficient therefore, to share parking facilities so that one car park serves both land uses.

The New Urbanism movement holds land efficiency as an important value, and provision of parking spaces is used as a tool to achieve high density developments[13]. According to the principles of New Urbanism, low parking supply and high densities encourages pedestrian movement at the expense of the car. As fewer parking spaces are needed, densities can be increased and walking distances between services and living space can be dramatically reduced[13].

The location of car parking facilities also presents a challenge in terms of competition with other transport modes[4]. A fast, new light rail line may lose passengers and revenue if there is ample free car parking near key stations and stops. Well planned car parks can instead support public transport infrastructure in the form of park and ride schemes, for example[4].

2.1.3 Mobility and accessibility

Parking controls can improve mobility and accessibility through reallocating traffic and by encouraging use of other more accessible forms of transport. The location of parking areas attract vehicular traffic, and if the parking area is accessed by a road which suffers from heavy congestion, then this congestion can be relieved by applying controls on the parking area in question[4]. Of course this only works when a cause of the congestion is the demand caused by the car park. If there is another cause to the congestion, such as a bottleneck or junction design, then parking controls may have little impact[4].

If a town has a good public transport infrastructure and a high quality cycle network, the strategic location of parking areas can discourage the use of the car as opposed to these more sustainable forms of transport[15]. Conversely this means, that large car parks can

act as a deterrent to public transport use if they work as competition to other transport infrastructure[4]

The design of car parking areas themselves often creates accessibility challenges. Parking areas usually demand a lot of space and parking spaces within a car park may be a significant walking distance from the final destination. Special attention should therefore be applied to the layout and location of parking spaces in order to improve overall accessibility[4].

The Espoo parking policy document covers accessibility and mobility goals more or less under the same banner as efficiency goals. There is an emphasis for example, on sustainability and encouraging different forms of transport which meet efficiency goals as well as accessibility and sustainability[3]. There are no specific policy goals on improving the layout of parking areas to reduce walking distances and to cater for those who use wheelchairs, although these are covered to some extent in building regulation guidance notes[20].

2.1.4 Equity of resources

Equitable distribution of the resources and services of a town can be influenced by specifying which user group is allowed to park in certain areas. Parking spaces are often already allocated for specific user groups such as employees, residents, or shoppers[4].

In a simple form, parking can be controlled with signs declaring that spaces are reserved for a particular user or user group, for example “Customers only”. But user controls can more complex and less direct, because different user groups have different requirements for where and how long they park for. It has been found, for example that in general, shoppers and visitors usually only need short term parking whereas employees and residents need long term parking[8], [17]. So if parking spaces are restricted to short term use, then they are benefitting people who park for short term, like shoppers or visitors, at the expense of those who park for long term like residents or employees[4].

There is also an economic argument, that parking fees are a useful tool for ensuring that the most important trips are made. Someone who has a good economic reason for travelling to an area is less likely to be turned off by the prospect of paying for parking[16].

But this may also mean that someone who has a smaller income is less likely to want to pay for parking than someone who is rich[8], [9]. In this way, parking fees, for example may not be ideal if the goal is to improve equitable distribution of resources based on level of income.

According to Espoo parking policy, effort should be made so that visitors and special groups can find parking spaces easily. There is also attempt to improve conditions for commuters by encouraging their use of public transport, walking, and cycling. The report claims that parking policy has more of an influence than public transport provision, on the way commuters travel to work. Equitable distribution of resources is not however, explicitly mentioned as a one of the principles of parking policy in Espoo[3].

2.1.5 Economic Development

The relationship between economic development and parking policy is not straight forward. Economic development may refer to the development of a town, but parking controls can produce revenue in the form of parking fees which might benefit the entire municipality. Also, in a sense, achieving environmental goals, cultural goals, accessibility and mobility goals, and efficiency goals may all indirectly contribute to the economic development of an area[15].

It was previously thought that relaxed parking controls and a large number of parking spaces were needed to attract shoppers, customers, office workers and employees to an area to support economic development[4], however more recent research has suggested that there is no relationship between the number of parking spaces in an urban centre and economic performance [12].

If parking spaces are in a limited supply, certain controls can be implemented to ensure that the most economically valuable trips are made. This would mean that office workers for example, would be favoured over people visiting an area to see friends or just to look around [16], [17].

The requirement for developers to provide parking spaces is seen as a burden which restricts growth. It is sometimes suggested that developers need to build a parking area

first and then construct a building that will provide enough profit to fund the parking area[7].

From the municipal authority perspective, controls in the form of parking fees provide opportunity for a steady and useful income stream that could support public services and potentially reduce taxation for other users[4]. Parking fees operated by the local authority can be seen as effectively moving money that would normally be spent on private goods and services to the public purse. If income from parking fees is then spent on maintenance, there is an argument that the overall local economic benefit is stronger than if the same money would be spent on private goods and services. This is because local authority maintenance is usually carried out by local contractors and employees. Money spent on private goods and services however, may move to foreign based exporters or outsourcers[14].

There is no explicit target within the Espoo parking policy to use parking controls to improve the economic development of an area. Nonetheless there are aims to increase density and improve efficiency of land use and transportation[3] which is likely to have indirect economic impacts[15]. In addition there is an aim to re-examine parking standards which, it is claimed, restrict development[7]. Perhaps most significantly is the aim to investigate the potential of parking fees which may produce new income streams for the municipality[3]. Economic development of course is mentioned as a key aim of the Espoo municipality. In the light of the European financial crisis and the decline of the technology industry in Espoo it is recognized that Economic growth forecasts are slow, and that in response to this development needs must be prioritised[21].

2.1.6 Cultural goals

It has been stated that car parks are dull places from an architectural point of view[7] and that parking policies can be implemented to protect the urban fabric or areas of high cultural importance[4]. The Espoo parking policy recognises this, and demands sympathetic urban design of parking areas by arranging architecture competitions for the design of car parks or using well disguised robotic parking solutions[3]. According to research in the UK however, residents have said that cultural and urban aesthetics is not as important as security and proximity of parking spaces[13].

2.2 *Parking controls*

The tools available to control parking have been identified as:

- supply controls (which effect the time needed to find a parking space) [4], [8], [22]
- price controls, [4], [8], [22]
- location of the parking space in relation to the final destination[4], [8],
- controls that favour certain user groups[4], [22], and
- restrictions on duration of parking[22].

In addition, factors that influence parking demand may include seasonal considerations, and external factors such as whether an area is in decline and does not attract traffic, or whether petrol prices have increased to the point that traffic decreases[23].

For a local authority, implementing parking controls becomes difficult if there is a large supply of private parking spaces available[16]. In addition, enforcing the chosen parking control can be expensive and complicated[16].

2.2.1 Total capacity of parking supply

Parking management strategies using supply controls can either increase or decrease the total volume of parking spaces to achieve the desired goals. It could also be argued that other parking control methods, such as by implementing prices or relocating parking spaces can be seen as some form of supply control too. These control methods are discussed in the subsequent sections.

Research suggests that increasing supply of parking spaces can result in parking congestion, which occurs when too many vehicles are trying to access the same parking area, and spillover, which occurs when people are parking in areas where they are not wanted. Conversely increasing parking supply does not have positive impacts upon traffic congestion, inequality, or environmental goals[15].

Nonetheless developers are often required to ensure a minimum amount of parking spaces for their project, whether it is for residential, employment or retail use. The minimum amount of parking spaces is defined by a parking standard which is enforced by the local authority through plans and conditions. This requirement however, is seen as being a cause of congestion[7], [14], [15]. It is argued that in a city with a high population density, one section of street has far more users than a street of the same size which is located in the sparsely populated countryside. The street is therefore much more likely to be congested, and the requirement to supply a minimum amount of parking spaces compounds the congestion problem by ensuring that vehicles will be attracted to the area[7], [15]. This is supported by other claims that traffic congestion cannot be solved by increasing parking supply[15]. Indeed, rather than a lack of parking spaces being the cause of congestion in a dense city centre, it is suggested that the lack of street space is the real reason that traffic jams occur[7].

Perhaps partly in response to this, pushing down the requirements of minimum parking standards has been part of the New Urbanism movement. Of course, fewer parking spaces also mean that land can be used more efficiently, and higher densities can be achieved[13]. But there is evidence to suggest that lower parking standards do not necessarily reduce car dependency[13], as provision of an alternative means of transport needs to be available. Consequently, it is suggested a more effective way of setting minimum parking standards is to divide a city into zones based on accessibility and proximity to the centre of the urban area[13]. Such a scheme has been recommended in Espoo, where for residential use, the amount of parking required decreases depending on proximity to the centre of an urban area and public transport provision[3].

2.2.2 Price controls

Of particular importance for this research is the concept of price controls for parking. Simply put, rather than being free, a price for parking is collected.

It is often feared that there will be significant public opposition to a local municipality that dares to implement parking fees[6] on previously free parking spaces. Politically, therefore, introducing parking fees can be difficult[15]. Nonetheless there are means to overcome public resistance[15].

If parking supply is to be controlled, it is argued from an economic perspective, that two problems arise. The first is an information problem. Motorists do not know before their journey how many spaces are available and so there is uncertainty in an economic model, whether the number of vehicles will be reduced or not. The second problem is that everybody has equal opportunity to access the spaces, meaning that people making the most important trips may not be able to park at the expense of people making less important trips [16]. So whilst it can be argued that reducing supply of parking through has benefits in terms of equality, there is a suggestion that allowing people to pay for parking ensures that those economically important trips will still be made[16].

As previously mentioned car parking fees can be used as a means of collecting Pigouvian taxation, whereby the negative social effects of car traffic are paid for by car drivers who cause these negative effects. However, it is argued that parking fees are not the most ideal form of taxation for car traffic because a parking fee does not consider how far someone has driven, or which route they took to get to the destination. A car that has been driven 30 miles through a residential area to get to a parking space would cause far more negative social impacts along its journey than a car that was driven just three miles along a motorway to get to the same parking space, but both cars would be subject to the same parking tariff structure. In this respect, instead of collecting parking fees, some form of road pricing would be a more optimal method of collecting Pigouvian taxation for car traffic[16]. However an advantage that parking fees have from an economic point of view is that they are location based and therefore more closely represent the price that somebody is willing to pay for a service[24].

Early research has found that parking fees can have a strong impact upon boosting municipal revenues, although long term reliability of this income stream is hard to predict [4]. Studies in Greece for example, found that the cost of maintaining a parking fee system was more than the money generated by the parking fees themselves[25]. Furthermore parking controls are difficult to implement if there is an abundant supply of free, private parking spaces, which the local authority has no control over, nearby[24].

Even so, the opportunity to make profit out of parking is an attractive proposition for local authorities, particularly during times of austerity[25]. If money can be generated

for a local authority by parking fees, the revenue streams can be used with other sources of money to pay for transport projects [24], [26], which may further improve accessibility and mobility, and help improve public acceptance of the fees[26].

Parking fees have been found to be very effective at reducing casual parking[9], increasing car occupancy[6], [23], reducing car usage and congestion [5], [7], [8], [10], [11], and thereby improving the promotion of efficient use of transport[4], [9], and land use[4]. Research in Helsinki and Espoo also claims that parking fees could reduce the use of the private car significantly[27]. Therefore parking management and pricing should be included as an important part of accessibility planning[24]. However, parking fees used in isolation can be counter-productive too. One effect that parking fees have is that they discourage long term parking which means that turnover of each parking space can be increased[22], [25]. The increase in turnover may consequently increase congestion and then reduce accessibility. If parking turnover increases to 10 cars a day, and if it takes a motorist on average three minutes to find a space, this equates to a total of 30 minutes that a car is on the road looking for a space, adding to congestion[26]. For the individual driver, searching for a parking space can be very frustrating and time consuming, with some research suggesting that looking for a parking space can cumulatively take many hours a month[28]. It may be, however that whilst parking controls can reduce congestion in some instances, the overall volume of vehicular traffic may not actually be reduced, rather it may be reallocated to other parts of the road network[12]. For this reason, the impact parking charges may have upon improving the environment is questionable[4], and from an economic perspective, the impact parking fees may have upon encouraging potential customers and employees to an area can be difficult to estimate [4].

Price control measures overlap to some extent with parking controls based on user groups. Employees for example, do not often have to pay parking costs because their employer will pay on their behalf [9]. This means that employees and workers have an advantage over other users in an area where parking fees are implemented. Shoppers and visitors for example, may be more willing to relocate and park elsewhere in order to avoid paying the highest parking fees[9].

Residents can also benefit from price controls if the local authority provides opportunity for a cheaper monthly parking permit for residents. In this way, the difference in price for non-residents and residents can sometimes be significant. In Amsterdam for example it was found that for non-residents the cost of parking was six times greater than it was for residents[29].

The economic argument for parking fees states that parking fees ensure that the most important trips will be made. Someone who really needs to go to the city centre would be more willing to pay than someone who does not have such an important reason to travel to the centre[16]. However, parking fees are a form of regressive taxation, and so it benefits those with higher disposable income. This was confirmed by a study in Sydney which found that people on low income were more likely to avoid paying for parking[9] and another study in Greece which found that income levels were important considerations in terms of decision making and parking fees[8].

Some studies have found that the hourly cost of parking is the most significant factor in influencing driver behaviour[9]. Also, the price of parking relates to the goals that the parking scheme is trying to achieve. For traffic management goals, it is suggested that high fees are needed for on street parking to reduce congestion[26]. If the aim of the scheme is to manage parking areas, prices should be set to discourage parking in times of high demand. For a local authority trying to maximise revenue, parking fees should be set at the highest acceptable market rate that will recover the cost of the parking space[15].

The hourly cost of parking therefore, deserves careful consideration. It has been recommended that parking fees should increase or decrease depending on user[10], location[15], [17], [23], and time of day [10], [15], [23]. Sometimes however, the rate of parking is based on the recommendations of an expert in the field, or prices can be established based on users' attitudes to what they consider would be high, reasonable or low fees[11]. Alternative methods for deciding the cost of parking include considering economic principles, and trying to offset external social costs of car traffic through parking fees, or setting parking fees according to the level of public transport provision nearby[11]. Some research has put the annual cost of an on street parking space, including operation and maintenance, cost of land, construction fees at nearly 350€, which

equates to 1€ a day[30]. As a minimum, parking fees should be trying to recoup this cost. If public transport provision is good, then parking fees can be adjusted so that they are no cheaper than the cost of a ticket on the public transport service[11], [15]. Setting a fee in this manner however, requires giving consideration to the fact that in general each passenger travelling on public transport has to buy two tickets, one for when they arrive and another for one they leave. So for a parking fee to be equal to or greater than the cost of public transport, the total cost of parking should be equal to two public transport tickets and paid by every passenger in the car[11].

House prices have been used in a study in Amsterdam to ascertain that the price that residents were willing to pay for parking is about 10 € a day[29]. This was based on a comparison of house prices which indicated that houses with available on street parking nearby were 6% higher in value than similar properties without parking facilities. This however contrasts to internal research undertaken by the Transport Planning Unit of the Town Planning Department at the City of Espoo which found no correlation between house prices and the availability of parking spaces.

Hourly parking fees do not have to be flat. A progressive system, in which each subsequent hour of parking is subject to an increasingly expensive fee, has also been recommended[15], although it is acknowledged that such a scheme may increase turnover of parking and thereby increase congestion[22]. Smart communication technologies also enable the opportunity for paying for parking in advance, and therefore a demand responsive pricing structure, similar to those commonly used by airlines, could be feasible and economically sound [10].

Typically, if a driver does not want to pay for parking then there are usually three options available; the driver can either stay away and not make the trip at all[10], park outside the parking fee zone which may increase the time a motorist is searching for an ideal parking space[26], or travel using a different mode of transport[10], [12], [26], which may involve car share and dividing the cost of parking[26]. However this list is perhaps not exhaustive considering that parking fees can be operated on a temporal basis, in which case the time the trip is made can be influenced[10], [16], [26]. If parking fees are only implemented for a few hours a day the fourth option available to a driver

who does not want to pay for parking, is the to make the journey slightly earlier or slightly later[12].

Espoo parking policy states that the parking should be paid for in a more just manner, and that the potential for parking fees in dense urban centres should be investigated. The aim of on street parking, according to Espoo policy, is to encourage residents to park within the grounds of their own property so that visitors and shoppers can find spaces more easily. A progressive parking tariff is therefore recommended to encourage short term parking. Parking fees can also bring in income for the City of Espoo and it is suggested that in Leppävaara alone, parking fees on 360 on street parking spaces might be able to generate an annual income of 1 million euro. The threat of private free parking areas is however acknowledged[3].

2.2.3 User group controls

The person who uses a parking space can be categorised according to purpose. Typical users of a parking space may include residents, employees, visitors, customers, tourists as well as public transport vehicles, taxi drivers, and delivery vehicles[15]. They can also be categorised according their characteristics such as long term or short term parker. Parking policies can be used to influence the purpose of the trip[16], [17], and therefore the user[15].

Residents usually require long term parking [8], [17] of between 6 – 8 hours[19]. A resident's car is parked at or near their home during the morning before they leave to work, and again in the evening when they return from work[17]. In dense urban areas it has been found that residents are more willing than other groups to use on street parking[17]. Employees also usually need long term parking spaces [8], [17], as the work day normally lasts about 8 hours[19]. This means that duration controls, ensuring that drivers can only park for short term may be effective at restricting user groups that need long term parking, like employees or residents[15].

For employees, parking fees may also be effective at discouraging parking in a certain location[9], [17], but employers often provide their workforce and customers with guaranteed free parking[4], [9] which means that parking controls implemented by the local authority on public parking spaces are less effective[4], [5]. Furthermore, employee

benefit often includes subsidies on car use including petrol and parking fees[9]. As a result, business people needing to park short term to attend a meeting may be more willing to pay for parking, as ultimately their employer will reimburse the cost.

Previous research has found that during the working day, the majority of cars parked in a city centre often belong to employees [8], [17], [25]. Perhaps because of this, it has been recommended that employee parking should be located on the periphery of the CBD[25], and employees should be encouraged to travel to their final destination using a different form of transport. Employee restrictions can be used so that they are prohibited from parking in the most convenient places[15].

Unlike employees and residents, visitors and shoppers normally require short term parking [15], [17], [25] and they do not have a guaranteed parking space, nor do they benefit from subsidies[9]. It might be because visitors and shoppers do not normally have a guaranteed parking space that they are more willing to pay for parking[17], although in some cultures visitors have been noted to avoid parking controls by parking illegally[25]. Research has also shown that residents want visitors to be able to park on site without having to search for a parking meter [13]. An advantage that visitors and shoppers have over residents and employees however, is flexibility. Visitors or shoppers can make their journey later, stay for a shorter duration, park elsewhere whereas employees for example usually have to be at work at a certain time and location [12]. Duration controls therefore may favour visitors and customers[15].

The location of parking spaces in relation to the final destination can be used as some form of user group control because different users are willing to walk further than others[17], [19], [25]. Research from America indicates that the size of the town impacts upon the distance people are willing to walk[19], but on average the usual distance walked from parking space to destination is about 150m[19]. It has been found that customers and shoppers are not willing to walk long distances to get to a destination[19][17] and so short term parking for visitors should be provided close to their final destination[25]. If an individual has a heavy load to carry for whatever reason, they will also want a parking space that is within close vicinity of their destination[28]. A study in Frankfurt found that residents and employees are willing to walk up to 300m to their final destination[17], which compares well with American

research suggesting that employees in a town of between 50,000 – 100,000 people are willing to walk about 125m to their destination[19].

In the previous section it was noted how the way that parking fees are implemented can give some different user groups an advantage. However, if parking spaces are restricted so that they are prohibited to specified user groups, those who may have benefited from a parking fee scheme are now excluded so that other users groups benefit from the parking spaces instead[19]. Indeed providing permits for different groups are important instruments to control on-street parking[17]. Such permit schemes are often applied for residents[15], and research has indicated that residential permit schemes have been effective at reducing the number of employees parking in the permit area[17], [22].

User controls can be used to promote equality and sometimes reduce congestion, if one particular group is seen as the cause of the congestion[4]. Espoo parking policy aims for special groups and visitors to be able to find parking spaces easily. In contrast there is emphasis on encouraging park and ride and sustainable transport for commuters[3].

2.2.4 Location controls

Location controls work by relocating parking spaces, or encouraging parking away from sensitive areas. In this way, location controls promote can help to achieve efficient land use, and may encourage economic development and the establishment a thriving retail environment that does not suffer from congestion[4].

Park and ride is a common location control, whereby large parking areas are provided away from the city centre and a regular public transport service moves people from the parking area to the city centre. It has been found that improvements in public transport and city wide parking strategies can have a key role in reducing motor traffic in the centre of cities[17]. Other research suggests that on-site parking requirements can be reduced by 10-30% if it is possible to park remotely[15].

It is important to note however, that a good public transport system is a vital part of encouraging remote parking. In some cases, motorists have parked further away from their

destination rather than using public transport because the provision of public transport was not sufficiently good[22].

Location controls can be indirectly caused by the implementation of other parking control strategies, such as parking fees or supply controls. If there are no parking spaces at the destination, or if the motorist is not willing to pay for parking, then they have to park elsewhere. Where they park is dependent on many factors. It has been found that different users are willing to walk further than others to avoid parking controls[17], [19], [25]. For example in Athens many drivers were willing to walk 10 minutes or more to avoid parking for paying[8]. Research undertaken in Helsinki and Espoo has suggested that motorists are prepared to pay so that they do not have to walk long distances to their destination[27].

When considering location controls it is worth remembering regional and local needs. Sometimes local areas have to make sacrifices to respond to regional requirements[24]. An example of this may be found in the centre of Leppävaara, where a car park for a regional park and ride service has been provided. On a regional level, this may prevent motorists from driving to the centre of Helsinki. On a local level however, it attracts vehicular traffic to the centre of Leppävaara.

Espoo parking policy calls for the development and expansion of park and ride schemes. It is hoped that this will reduce the distances that cars travel, and encourage cycling to public transport terminals. Furthermore Espoo policy suggests that parking areas should be centralized and shared to encourage a more enjoyable urban environment[3].

2.2.5 Temporal controls

Temporal and duration controls limit the amount of time, and time period, someone can use a parking space.

Temporal controls can be very effective in managing traffic volumes, because if a parking area is only open for a certain period then they will not attract traffic when they are closed[9]. Temporal controls can also determine whether parking is short term or long term which in turn impacts the user. Time limits of under 10 minutes would be suitable

for passengers drop-offs and deliveries, whilst 3-4 hour time limits prevent commuters from using a parking space throughout the working day[15].

In some cities it has been found that average parking time is over 5 hours[8]. If parking spaces are limited, reducing the duration that someone can park ensures that more people can use the same parking spaces[17], [22]. Most American cities therefore enforce time limits for on street parking to increase turnover. It is argued however that this is inefficient, because they only impact those people who would like to park longer than the time limit allows[14] and commuters for example, may move their car during the day to avoid possible fines caused by parking longer than permitted[15]. Duration limits are also difficult and expensive to enforce[14].

2.2.6 Combined controls

Parking management for a city normally involves a range of controls to achieve the objectives of the local authority. The diagram in Figure 1, adapted from previous research[17] indicates how combined controls can be used to manage the balance of parking based on supply and demand. Creating a city wide parking plan requires definition of the geographical scope, and carefully defining the problems that are trying to be solved[15]. It also is argued that any new parking scheme has to include private spaces too, even though they may be out of the parking authority's control[17].

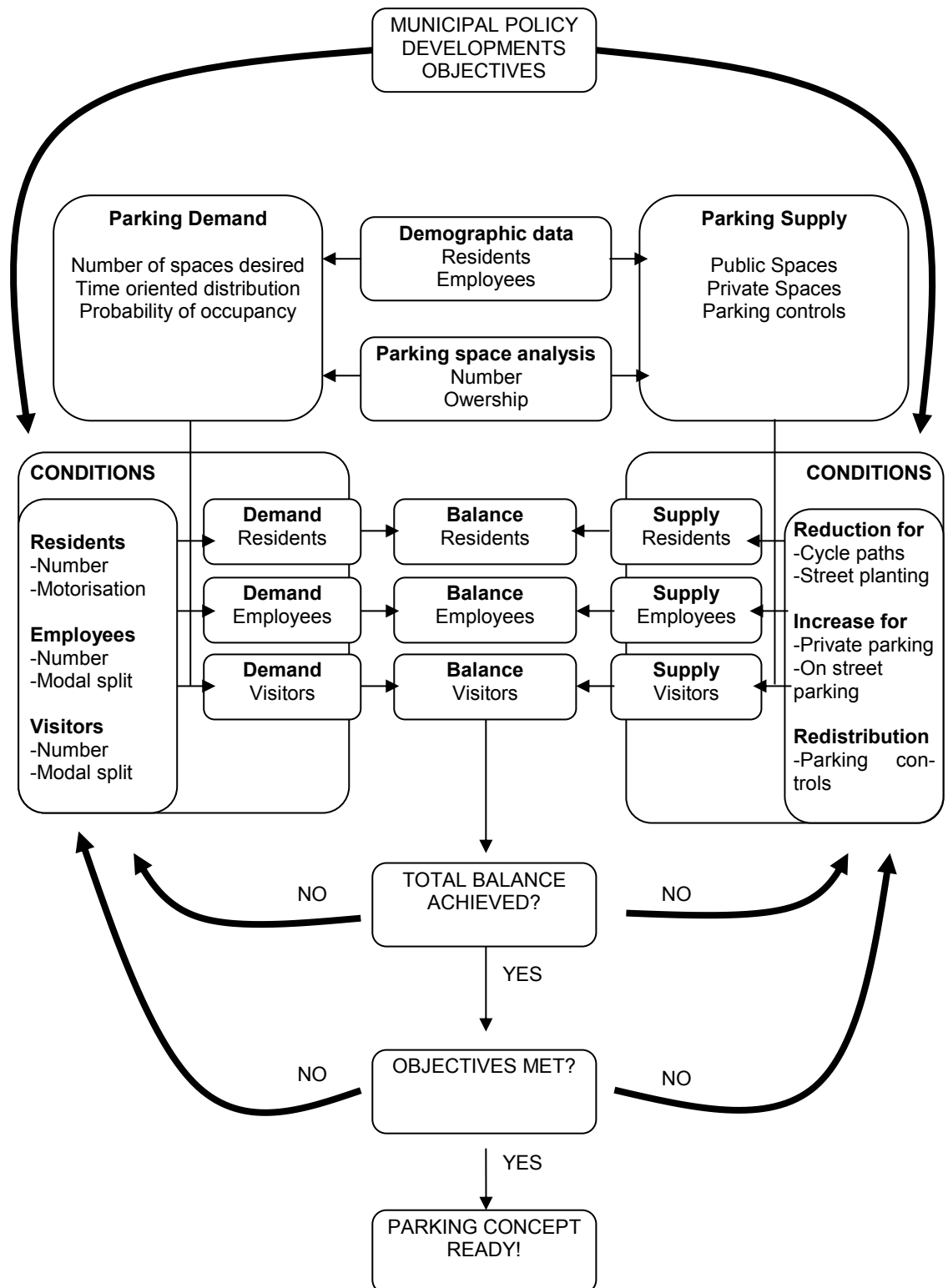


Figure 1. Balance of parking supply and demand, (Source: author, adapted from Topp, 1991[17])

2.3 Smart Parking

Smart parking forms a part of the smart city ideal, in which a city uses communication, sensing, and computer technology to improve efficiency and in which the residents of a city are better informed, educated and organised[31]. Smart parking can contribute to smart mobility which can mitigate against problems associated with peak hour traffic[31]. This section looks at some of the technologies available now to assist parking management and explores case studies of smart parking policies in action.

2.3.1 Technological developments and smart parking

A future scenario has been envisaged, whereby a motorist gets into a car and uses an electronic display to find a parking space before the journey starts. The price of the parking space is fully dynamic because it changes every minute according to the time of day, destination, and duration that the motorist will park for. An estimated price is offered and if the motorist feels this is too expensive, cheaper alternatives can be suggested[32]. Some dynamic parking schemes have already been implemented in cases around the world, but it is argued that they are too coarse with prices changing only a few times a day[32].

Elsewhere it is claimed that there is considerable demand for smart parking in the form of location based services that reduce cruising for parking spaces and subsequent driver frustration[33]. These services also solve the information problem that reduced parking supply had from an economic perspective[16]. A motorist can be informed whether the trip is worth making before the trip is made and so important journeys and congestion can be better managed.

There has been research into software architecture that monitors parking availability and congestion through wireless sensors and mobile technology and allows motorists to reserve spaces in advance[34]. Other schemes take congestion and mobility concerns into consideration to direct motorists to suitable parking spaces[31].

Operation of parking areas can also be achieved through automation, which saves on wages for employees such as parking inspectors who would have to manually check for illegal parking and issue tickets[19], [33]. In addition, paying for parking can be simpli-

fied using mobile applications as well as ticket machines. In the City of Helsinki, it is possible to pay for parking with a mobile phone using two separate service providers[35]. The city of Utrecht in the Netherlands has also implemented a system whereby paying for parking does not involve paper ticketing. In this system, details of the number plate were entered into the ticketing machine to indicate which car had paid for parking. This resulted in more efficient enforcement, undertaken by a scan car. For privacy reasons however, this was later amended so that it was no longer necessary to enter a number plate for short term parking[36].

In the City of Espoo an experiment based on mobile phone sensors to detect how someone arrives to, and leaves a parking area. The speed and location sensors indicate whether someone arrives by car and leaves on foot, which means they have found a space. This crowd sourcing technique can be used to track how many spaces are available in a parking area without the need for additional sensors[37].

Robotic parking and other mechanical parking systems also form a part of the smart parking concept because of their use of technology. They can involve stacking systems, where two or three cars are moved and stored above each other in a stack. More complex systems comprise of underground towers which involve lifts to move cars to available levels. These systems are more effective in city centres where land prices are high[19]. However, they are expensive to install and operation and management costs are expensive too. Furthermore, it can take some minutes to for a motorist to retrieve a car that has been parked in one of these systems[19].

In San Fransisco, smart parking solutions were integrated within a dynamic parking scheme. A parking management program SFPark was implemented which used sensors to monitor occupancy of parking spaces. Parking prices were increased or decreased over a set period and any increases were announced in advance to ensure that motorists were aware and informed[38]. The aim was to try and ensure a maximum occupancy rate of about 85%[18]. Research has found that cruising for parking spaces has been reduced by about 50% because of the parking scheme. Furthermore, the occupancy rate goals were generally achieved[18].

A scheme involving management of about 2,400 on-street parking spaces with sensing technology has been implemented in the city of Treviso, Italy. When a customer parks in a marked on-street parking space, they are requested to enter which parking space they are using as they pay. This means that a computer can automatically check whether a fee has been paid for a car parked in a certain parking area[36].

The City of Espoo parking policy fully supports investigation of smart parking possibilities and aims to become a leader in the implementation of such technologies. To support this, it is recommended that a database of parking spaces, including information on route guidance, accessibility and electric car charging points is created. Furthermore, it is aimed that more land use efficient robotic parking schemes are trialed[3].

2.4 Summary and potential impacts for Espoo

To summarise, and to apply previous research on parking and smart parking solutions to the Espoo case, a good starting point would be by looking again at the goals that the City of Espoo is trying to achieve.

The economic development goal identified in the Espoo story is important. Economic growth is forecast to be slow and so development goals should be prioritised[21]. At the same time it is forecast that jobs and population in the municipality will grow significantly due to urbanisation[1]. Parking strategies therefore should support development and economic growth. The Espoo parking policy suggests that amount of parking that developers are required to build for their new developments can be reduced[3]. This is a supply based control that may help stimulate growth. In line with this, more efficient land use is promoted by the Helsinki Regional Transport System Plan[1]. Parking strategies suggested by Espoo policy, such as implementation of parking fees and investigation of smart parking technology[3], may help to achieve more efficient land use. Of course parking fees will also respond to economic development objectives by generating money for the municipality[3].

The development of smart technology mean that operational obstacles to a parking control scheme can be managed more effectively[32], [33]. Information can be provided to

motorists before their journey so that traffic management goals can be more easily achieved.

Smart parking forms a part of smart mobility which has been interpreted in the mobility as a service concept promoted by the City of Helsinki[2]. To promote sustainable mobility it is argued, parking spaces need to be managed effectively. This may mean using parking fees to discourage parking and encourage the use of public transport for example[2].

3 Methodological Approach

This section introduces methodological aspects of the research, including a summary of interviews held with field experts and an introduction to the quantitative research.

3.1 *Interviews with field experts*

Interviews were held with three experts. They were:

- Mika Rantala, Leppävaara Project Manager at the City of Espoo. As Project Manager his responsibilities include enabling development in Leppävaara which involves working closely together with private stakeholders and public interests. Mika Rantala was involved in creating the Mission Leppävaara interface (Tehtävä Leppävaara)[39], which allows the public to see a 3D-model of future development projects in Leppävaara and provides opportunity for anyone to comment upon planning or environmental issues in Leppävaara.
- Kalle Toiskallio, a smart parking expert currently employed as CEO of Enterlot Ltd. The company provides guidance to all people entering parking lots and buildings. The aim is to increase parking turnover, reducing cruising for parking, and increase customer satisfaction. In the long run, it is hoped the service will enable reduction in the total amount of parking spaces. The project is operational in various locations around the HMA[40].
- Ali Lattunen, Technology specialist at Finnpark Ltd[41]. Finnpark are responsible for the operation of various parking areas around Finland, including in the City of Tampere where Finnpark operates about 4000 on-street parking spaces in the City.

3.1.1 Interview structure

Interviews with Kalle Toiskallio and Mika Rantala were face to face. The interview with Ali Lattunen was conducted over the telephone. Interviews were conducted in Finnish and a summary of the interview later translated and sent to the interviewee for final approval.

Prior to the interview some brief information about the research and a draft of the survey was sent in advance so that interviewees could prepare. Interview questions focused upon the parking and challenge of urbanisation, the impact of on street parking fees, the principle of dynamic pricing with time and location variables, and advice regarding the survey proposal for the quantitative research.

3.1.2 Parking and the challenge of urbanisation

When asked about how parking can impact upon development and city growth, Mika Rantala immediately admitted that parking is one of the biggest challenges in trying to create a dense city centre. For example a developer wanting to build an office block in the centre of Leppävaara may be commissioned to provide a certain amount of parking spaces for future employees and customers. Sometimes the number of spaces desired by the land developer exceeds the minimum amount of spaces required by the City authority, even if there are good public transport links nearby. The task of fitting the desired number of parking spaces within reasonable distance of the office development can be impossible to achieve and development may be stalled as a result.

Within Leppävaara, Mika Rantala said that although there is a high number of private parking spaces, parking facilities are often full without spare capacity. This makes the challenge of finding new spaces to support new development difficult.

A proposed solution to this, Mika Rantala suggested, would be shared parking. Often the private parking facilities used by employees and office workers are empty in the evening when they could be used by residents. If they were shared, residents could park in these facilities over night, however it would be problematic if in the morning when employees arrive to work by car before the resident had not vacated the space.

Ali Lattunen confirmed that the requirement to provide a minimum number of parking spaces can make development challenging. The development of large underground car parks or multi storey parking facilities can have a positive impact however. In Tampere many on-street spaces were replaced by parking spaces in parking facilities. This freed up land for public transport lanes which improved accessibility in the City.

3.1.3 Parking fees

Mika Rantala suggested that parking fees are essential, especially in areas where residential developments have alternative centralised parking facilities nearby. For example in Leppävaara, a recently approved development involves a parking facility that is shared between different housing companies. A monthly fee is collected from users of these centralised parking facilities and so if on street parking was free, residents would be encouraged to park on street to save money. In addition, Mika Rantala said that on street parking fees could help reduce car traffic by encouraging people to use public transport instead.

Kalle Toiskallio agreed that parking fees are an important tool to manage parking behaviour. He pointed out, however that people are prepared to go to significant lengths to avoid parking fees. He remembered an example from the suburb of Pasila, near the centre of Helsinki where a development comprised of a large underground parking facility which required a fee for use. According to Kalle Toiskallio, when this facility was created, residents and visitors preferred to park off site, and walk up a steep hill to avoid paying parking fees. Another example was the Hartwall Arena ice hockey stadium and concert venue, which charged 8€ for the duration of an event. Motorists are prepared to walk significant distances to avoid these fees.

Ali Lattunen also felt that parking fees are necessary for various reasons. In terms of equality, he said that parking fees encourage shorter term parking, which means that the same parking space can be used by many different users. If parking spaces do not have restrictions, then there is a danger that they are only used by the motorist who gets there first. Also parking fees ensure that the space is used by someone who needs it. If a private shopping centre offers free parking, then a motorist may park in the private parking area but then walk to another destination entirely.

Furthermore, Ali Lattunen brings up the point that the cost of parking, including land, maintenance and operation, is not free. It is fair therefore, that the motorist who uses the space contributes to this cost. In relation to the cost of developing a parking space, Mika Rantala pointed out the fact that in many residential developments, the cost of the construction of a private parking space is bundled into the cost of all properties for sale. This means that non car users pay for parking when they buy a flat on the property. A

monthly fee is often recovered by the housing company for the privilege to use a parking space but this fee is usually needed for maintenance only and does not take into account construction costs.

Regarding the price of parking, in Tampere the cost of a public parking space is decided by politicians, who make their decisions as a representative of the people, rather than solely based on facts and research. The current hourly cost of parking in the centre of Tampere is 3.20€[42] and this fee has evolved over time based on political decision and discussion. For Ali Lattunen, it is important that on-street parking fees are more expensive than parking fees in underground car parks or multi storey parking facilities. This is to encourage parking off-street so that the streetscape can be more aesthetically pleasing.

Ali Lattunen remembered that another factor that politicians decide is the duration and days on which parking fees can be collected. In Tampere for example it was decided that on-street parking would be free on Sundays. This is a decision that Ali Lattunen does not entirely agree with, as in his opinion parking fees should be collected every day.

Private parking facilities can sometimes be a threat if they offer free parking. Ali Lattunen pointed out the example of the City of Kuopio in Finland, where on-street parking spaces and spaces inside a large underground parking facility were subject to parking fees. Within the same area however, a shopping centre provided free parking. Nonetheless, those free parking spaces had a limited capacity and Ali Lattunen said it is important to remember that the users of those spaces are not necessarily customers of the shopping centre. A shopping centre in Tampere on the other hand charged a fee for use of their parking facilities to ensure that there is a steady flow of new customers. In any case, a parking strategy for a town or city, according to Ali Lattunen, should take in the whole area and not just explore small pockets of parking problems.

Kalle Toiskallio suggested that should Sello shopping centre in Leppävaara start charging for parking spaces, there is a risk that customers would shop elsewhere. In the HMA there are several competing shopping centres within a relatively short drive of Leppävaara. But the fear that parking fees could discourage customers from visiting

shopping centres in Leppävaara could be alleviated using demand based pricing, according to Ali Lattunen. If the Sello shopping centre implemented parking fees and noticed a considerable reduction in the number of customers, then they could adjust the parking fee accordingly. One problem however, is with enforcement, as it is not good for the reputation of a shopping centre if they have to hand out large fines for parking infringements.

Ali Lattunen feels that with shopping centres it is difficult to encourage people to use public transport if they have visited the supermarket and are carrying bags of shopping for example. Nonetheless good public transport links can have a significant impact on parking demand.

For employees, Kalle Toiskallio pointed out that in Finland employers often provide free parking for workers and customers to help generate and enable business. This is encouraged by the fact that businesses can include the rent paid for parking facilities within their total annual costs, which can then be used to help reduce their tax responsibilities.

In terms of what a reasonable hourly price for parking should be, Mika Rantala suggested a 1 – 2€ maximum. He stressed however, that this was a just a personal opinion. Kalle Toiskallio also suggested 1 - 2€ as a personal opinion for the City of Espoo. Ali Lattunen on the other hand believed that on-street parking fees should be more expensive than fees in parking facilities, and that they should be comparable to the cost of a public transport ticket.

3.1.4 Principle of dynamic pricing

Both Mika Rantala and Kalle Toiskallio said that the geographical parking zones proposed in section 4.3 looked acceptable in principle. Mika Rantala also confirmed that some form of pricing would be desirable if used in conjunction with other measures to reduce car use.

Ali Lattunen had some experience of geographical parking zones as they are implemented in Tampere. The idea of the zones in Tampere is based on demand. Where there

are fewer spaces and more customers, such as in the centre of town, parking prices are higher. The geographical scope of the zones were not established by set distances, instead important streets and other barriers were used to define the limits of each zone.

Ali Lattunen was enthusiastic about the idea of time variable parking fees. He pointed out, that to some extent they already exist as parking fees are not usually collected during the night time. For Ali Lattunen, a better solution would be demand variable parking fees with prices that fluctuate over time according to how many free spaces are available. At busy times, the final free parking space would be priced so that only those motorists who really need to park, would park.

Although Ali Lattunen believes that time variable parking fees are a good idea, he does not feel that they will be implemented in Tampere in the near future. There is not much political will for such a parking scheme and ultimately politicians decide the parking tariffs for public on-street parking. Even private stakeholders such as shopping centres in Tampere do not seem to be too interested in developing demand dependent parking fees.

3.1.5 Comments regarding the survey

Ali Lattunen suggested that a postcode question in demographics would be particularly important. According to Ali Lattunen, the postcode can reveal additional information such as why someone is travelling to Leppävaara and what sort of people are visiting.

Ali Lattunen also stressed the importance of delivering the survey to non-motorists as well as motorists. Of course motorists would answer that parking spaces should be free and located right next to their final destination. It is vital to hear the opinion of other transport users who also share the same infrastructure and bear the cost of parking.

Kalle Toiskallio agreed that distribution was important. The survey should consider those who do not visit the study area very often compared to those who visit on a more regular basis. It is likely that there would be some variation in response according to this parameter.

An interesting question that Ali Lattunen suggested would be to investigate what someone would be willing to pay for parking in a situation where the parking capacity resource is limited and paying a fee would guarantee a parking space. Ultimately however, it was not possible to include such a question, as effort was made to keep the survey as short as possible.

Kalle Toiskallio stressed the importance of keeping the survey as brief as possible, with a maximum of 10 questions. He said the layout was also important, and recommended using plenty of white space to keep things simple and to encourage people to fill in the survey.

In the first draft of the survey, Kalle Toiskallio noticed overlapping answers in some multiple choice questions. He recommended eliminating these to avoid any confusion. Previously for example, a question regarding what the respondent considers a reasonable fee for parking might have answers as 1 - 2€, and 2 - 3€ and so on. Following this advice, answers were amended to 1,01 - 2€, 2,01 - 3€ and so on.

In addition Kalle Toiskallio identified the scenario questions as being particularly challenging. He noticed that the question demands the respondent to consider a lot of information, such as purpose, time and zone. An alternative in his opinion would be to consider dividing the question so that first the respondent considers how they might react to time restrictions and then ask about geographical restrictions.

3.2 Survey

The second part of the methodological research involved a survey. Whilst interviews provide real world insight into experiences with parking policy and how parking controls may influence behavioural patterns, to obtain an idea of public opinion it was felt that a survey is required.

For this research, an online survey was undertaken for ease of use and to try and attract as many responses as possible. Research has indicated that web-based surveys can attract responses from a diverse demographic, and that repeat responses, or responses that do not take the survey seriously are usually minimal so that they do not impact upon results[43].

Information about the survey set up, results and analysis can be found in the forthcoming chapters.

4 Case study background

In this section the research will explore the practical background, including an introduction to the study area together with an assessment of the study area's existing car parking situation. Finally, a parking control scheme will be proposed which will form the basis of the quantitative research.

4.1 Introduction to case study area

The City of Espoo was chosen as the municipality within which to conduct the research for two reasons, first because of the local authority's recent development of new parking policy and second because of the pressures to increase growth within the district. Within Espoo, the urban centre of Leppävaara was selected as the study area. Leppävaara was chosen because it is the largest centre within the municipality and therefore likely to attract more interest from the general public. Leppävaara also shares characteristics with other urban areas within the City of Espoo in terms of infrastructure and services, which means that the results of the research can possibly be applied elsewhere.

4.1.1 Helsinki Metropolitan Area

The Helsinki Region is comprised of 12 authorities of which the HMA is made up of the four central municipalities; The City of Helsinki, The City of Espoo, The City of Vantaa and Kauniainen. The location of these municipalities is illustrated in Figure 2.

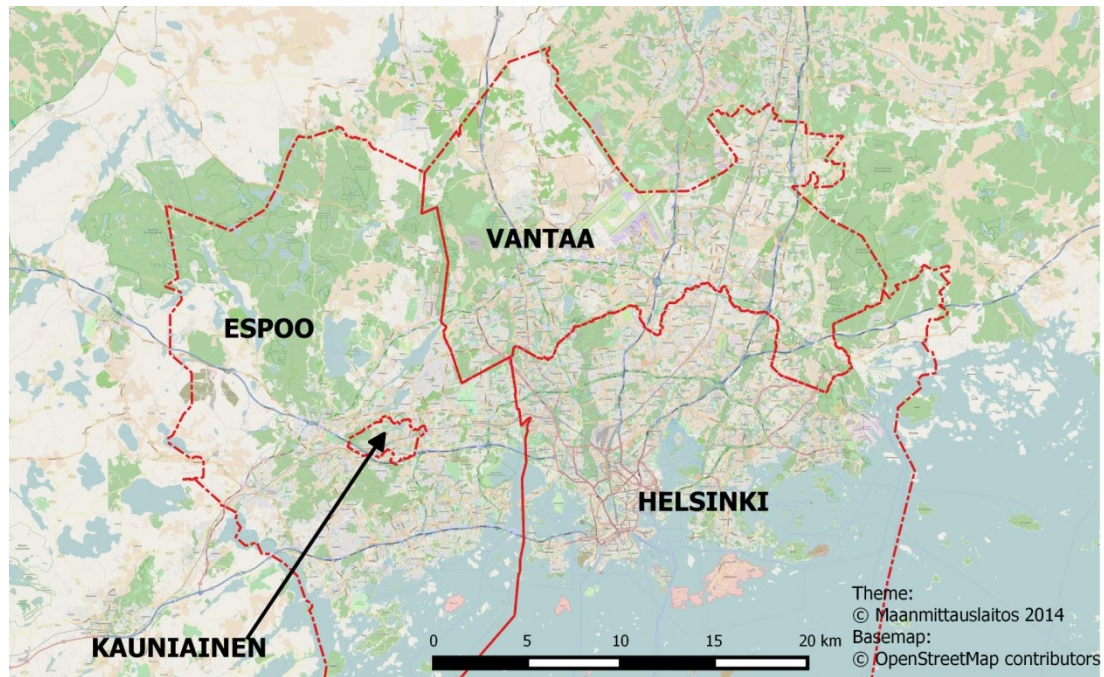


Figure 2. Municipalities within the Helsinki Metropolitan Area

The City of Helsinki is the largest municipality in Finland in terms of population, with over 600,000 residents[44]. In comparison, the population of Espoo is about 260,000[45] which is slightly more than in Vantaa[46], making it the second largest municipality of the HMA. Kauniainen is located entirely within Espoo and is the smallest municipality of the HMA with a surface area of just 6km² and a population of under 10,000[47].

Road transport in the HMA is dominated by six arterial highways which connect Helsinki to other major cities within Finland, and two orbital motorways, the Kehä I and Kehä III ring roads. A third orbital motorway, the Kehä II ring road, has been planned for a long time, and has been partially constructed in Espoo. For rail transport, there is a local metro line which links East and South West Helsinki. This line is now being extended into Espoo and is due to open in 2016. A commuter rail network serves Northern Helsinki and Central Espoo. In the municipality of Vantaa, two commuter rail lines have recently been connected with what has been called the Ring Rail line. Transport infrastructure in relation to Leppävaara is shown in Figure 3.

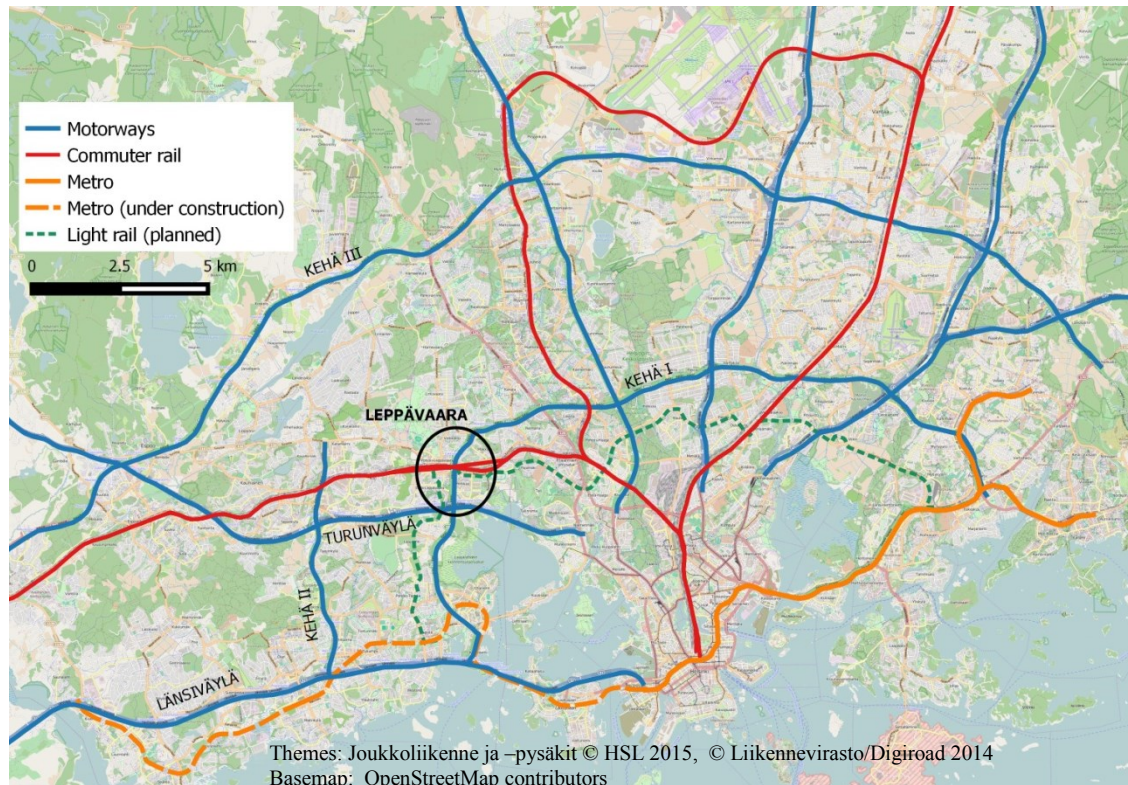


Figure 3. Transport infrastructure of the HMA in relation to Leppävaara

4.1.2 The City of Espoo

Espoo is a polycentric municipality with the population mostly dispersed over five urban centres located along two public transport corridors (see Figure 4). In the south of the municipality the extension to the Helsinki metro line from the centre of Helsinki towards Espoo will connect the centres of Matinkylä and Tapiola in 2016. A further extension of the metro towards Espoonlahti is planned to be completed in 2020. Running through the middle of Espoo, a commuter rail line serves the urban centres of Espoon Keskus, Leppävaara, and the municipality of Kauniainen.

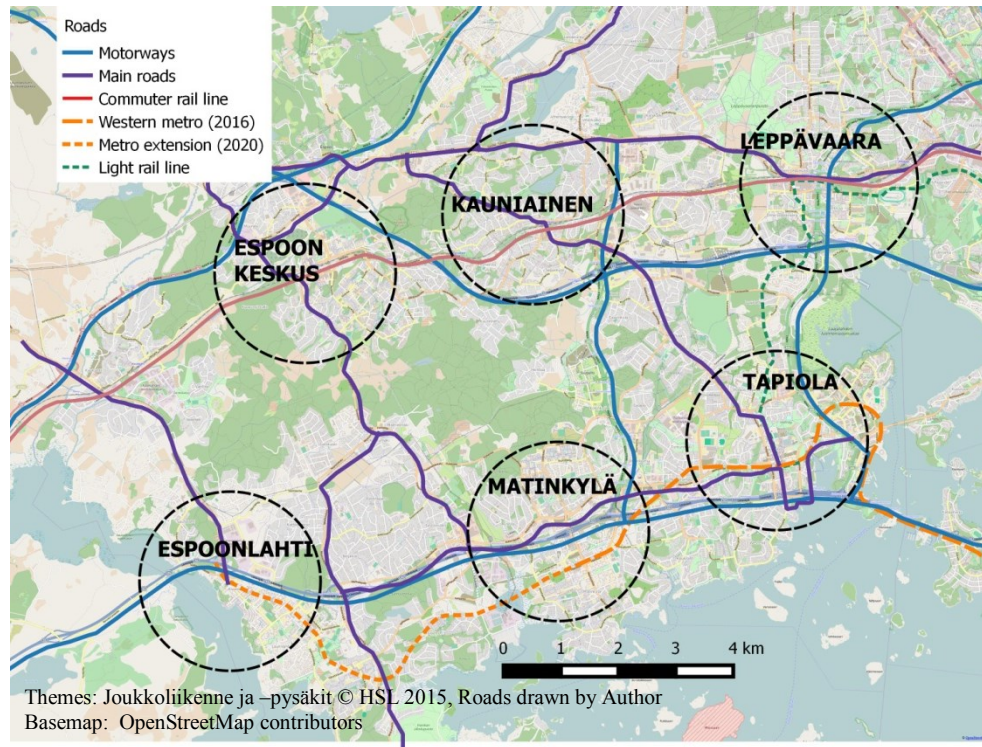


Figure 4. Location of urban centres and transport infrastructure within the City of Espoo

The population in 2014 / 2015 of each urban centre is presented in Table 2.

Table 2. Populations of urban centres within the City of Espoo (Source: City of Espoo 2015[47])

<i>Urban Centre</i>	<i>Population</i>
Leppävaara	29,285
Espoon Keskus	25,101
Espoonlahti	24,063
Tapiola	20,119
Matinkylä	20,092
Kauniainen	9,357

4.1.3 Leppävaara in detail

The focus of this research however, falls upon the urban centre of Leppävaara.

Leppävaara is situated approximately 10 kilometres north west of the centre of Helsinki and has the largest population of Espoo's urban centres[45]. The inner orbital ring road of the HMA, Kehä I, runs from north to south through Leppävaara and the Turunväylä motorway between the City of Turku and the HMA, skirts the south of the area. Another main road, the old road between Turku and Helsinki named Turuntie, runs east to west through the centre of the area. The railway line runs almost parallel to Turuntie and serves mainline trains between Turku and Helsinki and commuter trains between Leppävaara and Helsinki. The mainline trains do not stop at Leppävaara. Transport infrastructure is displayed in Figure 5.

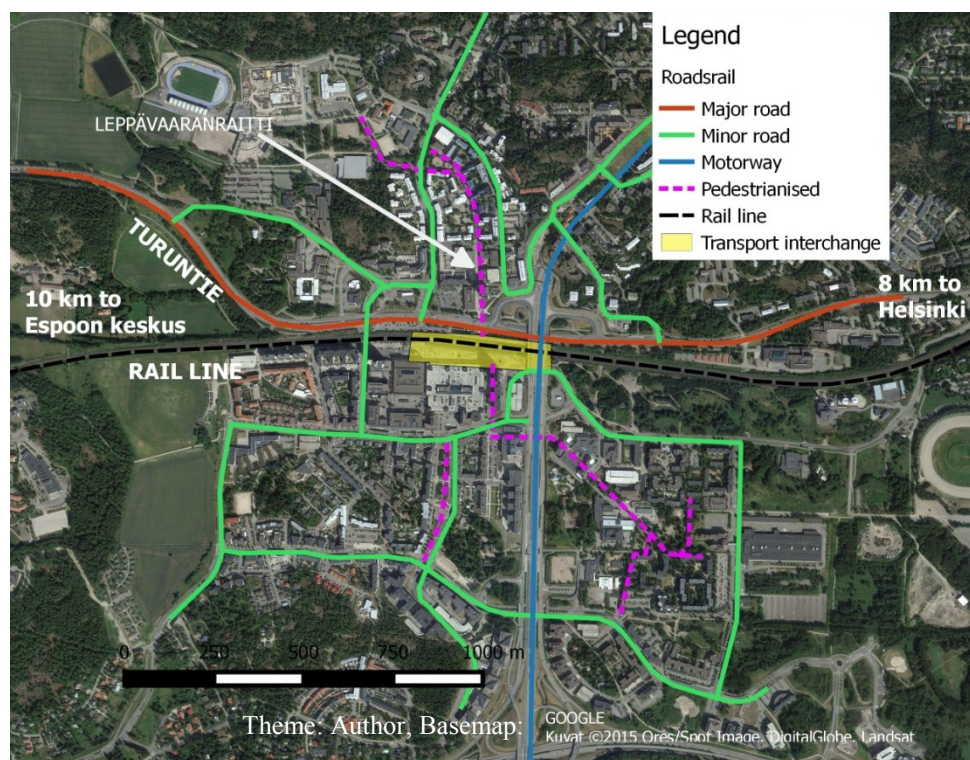


Figure 5. Major roads and transport connections in Leppävaara

Land use

In the centre of Leppävaara, just south of the commuter railway station there is a large indoor shopping centre called Sello, which has almost 100,000m² of rentable retail space, making it the second largest shopping centre in the HMA[48]. In 2012 it attracted over 22 million visitors[48]. To the north of the commuter railway station is an older and smaller shopping centre, Galleria. A pedestrianised street, named Leppävaaranraitti, connects Sello and Galleria via a tunnel which runs underneath the railway station.

Elsewhere the centre of Leppävaara is characterised by fairly high density residential development. The average floor space index of Leppävaara imposed by planning regulations is approximately 0.45 which makes it the second highest of all sub-centres within the HMA, behind the suburb of Pasila which is located just a few kilometers north of the centre of Helsinki[49]. Commercial office developments have been constructed to the south of the study area and also in the centre of Leppävaara. Services including a library, schools, and a sports park are also found within the study area. Land use is illustrated in Figure 6.

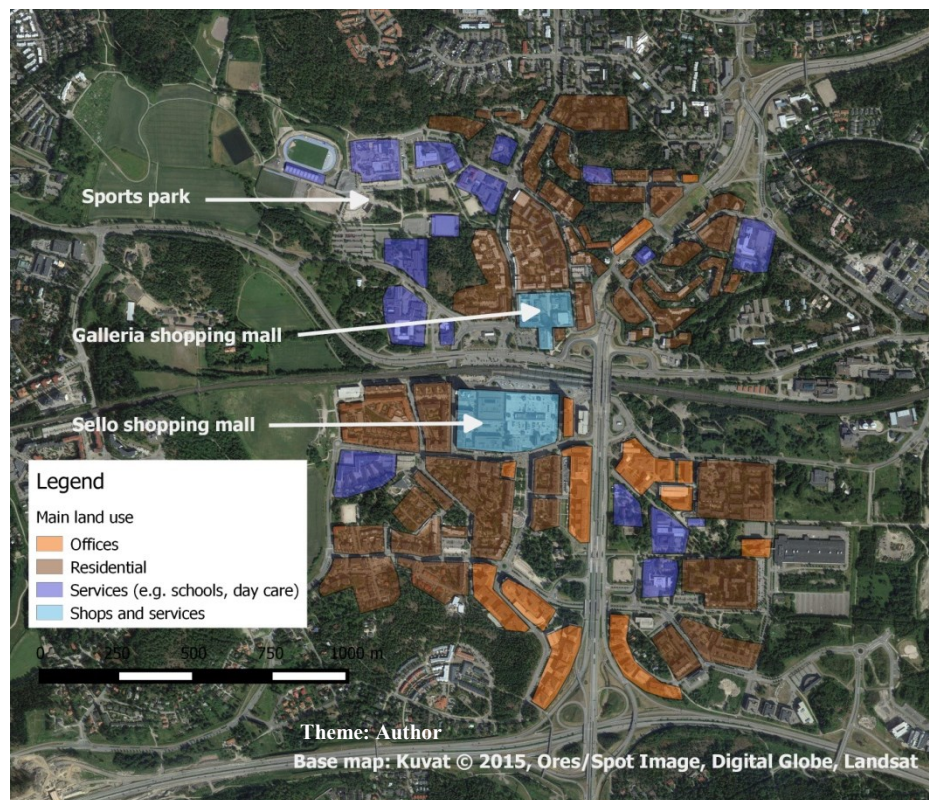


Figure 6. Main land uses within the Leppävaara area

Accessibility

In conjunction with the Helsinki Regional Transport System Plan 2011, research was conducted into the accessibility of the HMA. The Helsinki region was divided into a grid-network of 250m x 250m cells and an accessibility level for each cell was defined from the point of view of sustainable transport modes such as walking, cycling and public transport. In the HMA, there are corridors of high accessibility which are located alongside rail infrastructure and converge in the centre of Helsinki[50].

Figure 7 shows the accessibility zone analysis for Leppävaara. According to the research, Leppävaara is defined as having accessibility level I or II. Level I means that people in Leppävaara can get to their final destination on foot, by bike or with a very frequent direct public transport connection. Level II means that people of Leppävaara can get to their final destination on foot, by bike, or with a frequent direct, or frequent indirect public transport connection[50].



Figure 7. Accessibility zones in Leppävaara (Source: HSL and Strafica Oy 2012 [50])

The extent of level 1 accessibility in Leppävaara measures slightly more than 1km², and is centered on the railway station and public transport interchange. Level 2 accessibility covers most of the remainder of Leppävaara. To the north of Leppävaara is the suburb of Lintuvaara, which has accessibility of level 3. This means that people of Lintuvaara would access their final destination by a fairly frequent, indirect public transport service, or by car.

According to accessibility research therefore, Leppävaara is one of the most accessible urban areas of the HMA. This impression is confirmed to some extent by travel time maps, which as Figure 8 indicates, show that someone leaving from the centre of

Leppävaara at 8am on a weekday morning in March 2015 could within 30 minutes, have travelled across a broad area by foot, bike, or public transport.

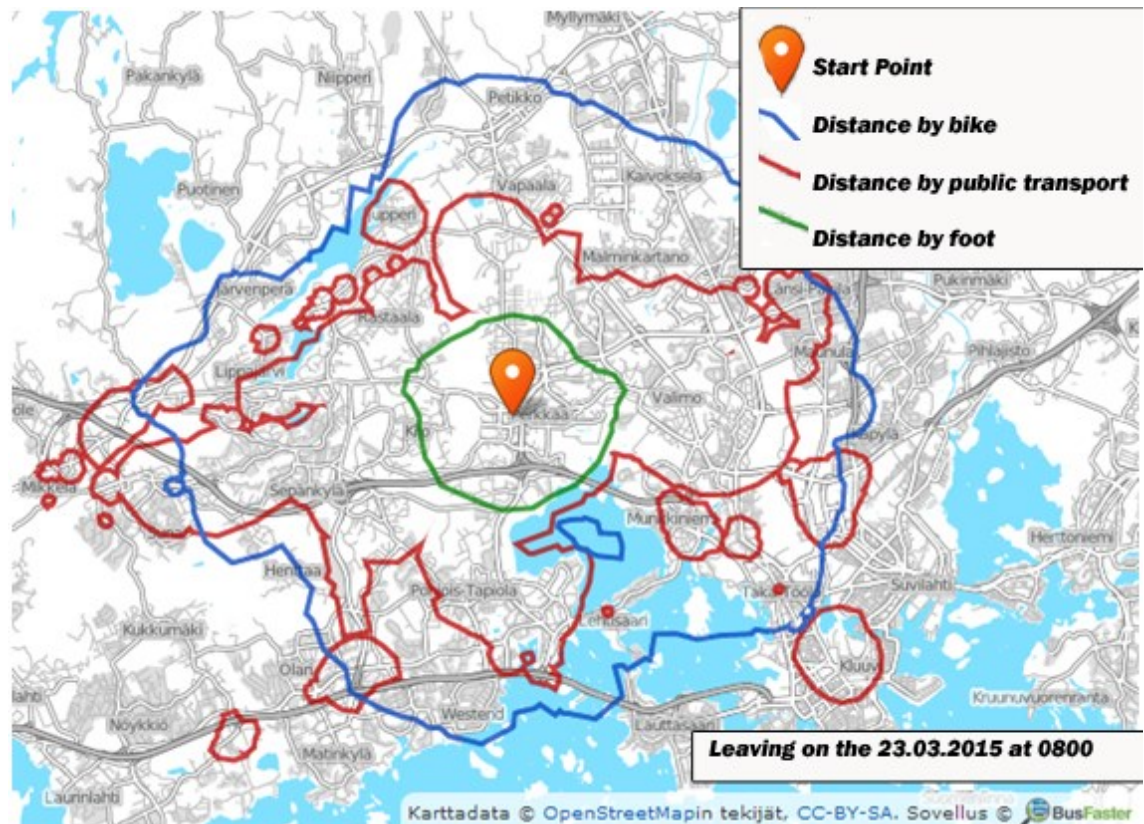


Figure 8. Travel time map showing distance possible to travel from the centre of Leppävaara (Source: adapted from HSL 2015[51])

Public transport

Good accessibility in Leppävaara is encouraged by a busy public transport interchange in the centre. The bus network serves the train station in Leppävaara which has regular services to Helsinki and Espoo. On a normal weekday morning there are up to 12 trains an hour from Leppävaara to Helsinki and four trains an hour between Leppävaara and Espoo[52]. Bus number 550 is a popular orbital line which connects Espoo to Eastern Helsinki. The bus operates on 5 minutes intervals and in the future will be replaced by a light rail line.

Figure 9 shows the number of passengers getting on a public transport service in Leppävaara. In and around the public transport interchange, 20,000 passengers were counted getting on a public transport service during a weekday in September 2014[53].

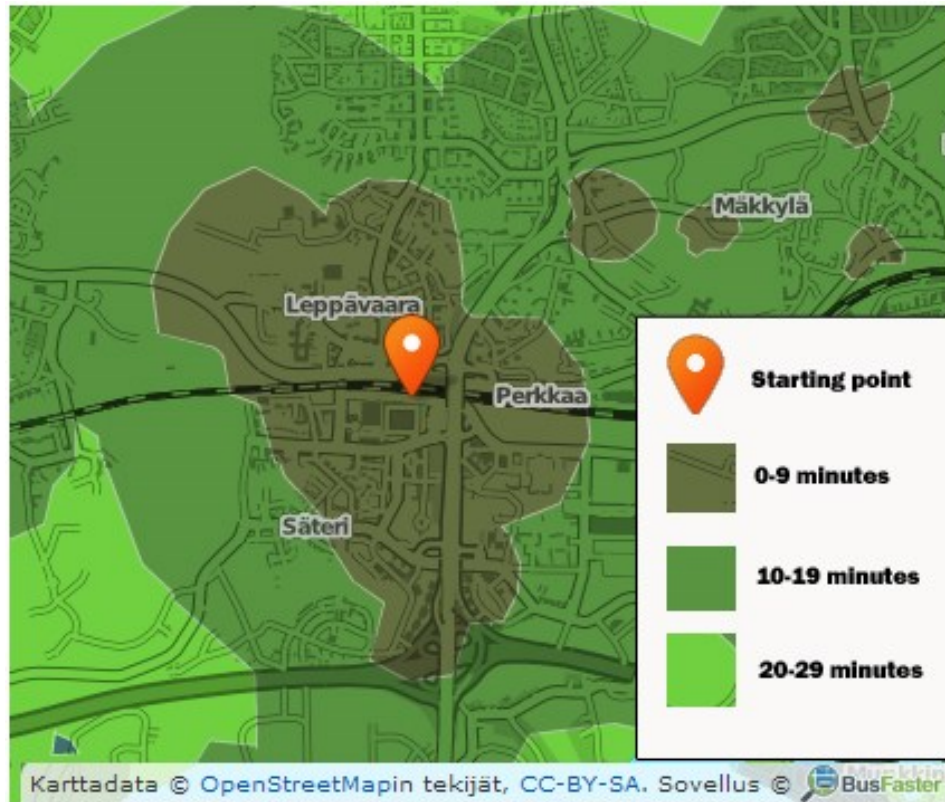


Figure 10. Distance travelled by bus in different time categories (Source: adapted from HSL, 2015[51])

This is consistent with data from the accessibility zones which showed that the area with the highest level of accessibility was stretched to some extent in a north-south direction over Leppävaara.

In Leppävaara a 2012 survey, the Transport Barometer conducted by TNS Gallup Oy and commissioned by the City of Espoo, indicated there is a positive opinion towards public transport in Leppävaara. It was found that 66% of respondents from Leppävaara said that public transport worked well, or very well and nearly 30% were satisfied with public transport provision. Only 3% of respondents from Leppävaara said that public transport was poor. This positive feedback was replicated in other urban centres in Espoo[54].

Private car

The Leppävaara area sees large volumes of vehicular traffic which is influenced by the presence of two motorways. Kehä I had an average weekday traffic volume of nearly 100,000 vehicles in 2014, which made it the busiest motorway in Espoo. The Turunväylä motorway to the west of Kehä I carried nearly 80,000 vehicles a day on average.

Of the remaining roads, Turuntie, which runs through the centre of Leppävaara took over 20,000 vehicles a day, making it one of the busiest roads in the municipality. The other major roads within Leppävaara carried between 5,000 to 10,000 vehicles a day on average in 2014[53]. Traffic volumes of main roads in Leppävaara is displayed in Figure 11.

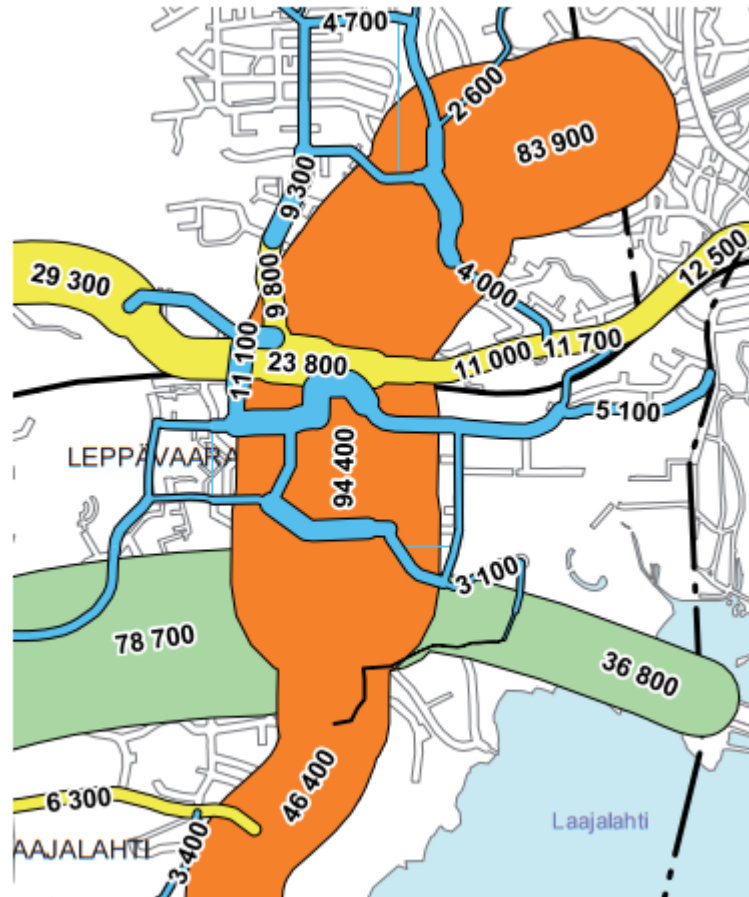


Figure 11. Average weekday traffic volumes in September 2014, Leppävaara (Source: City of Espoo, 2015[53])

Despite these large volumes of traffic, statistics show that in Leppävaara 50% of households do not own a car, 42% have one car and 8% of households have more than one car. The number of households without a car is slightly below the average for sub-centres within the HMA[49].

Figure 12 shows density of car ownership within Leppävaara taken from information provided by Statistics Finland[55].

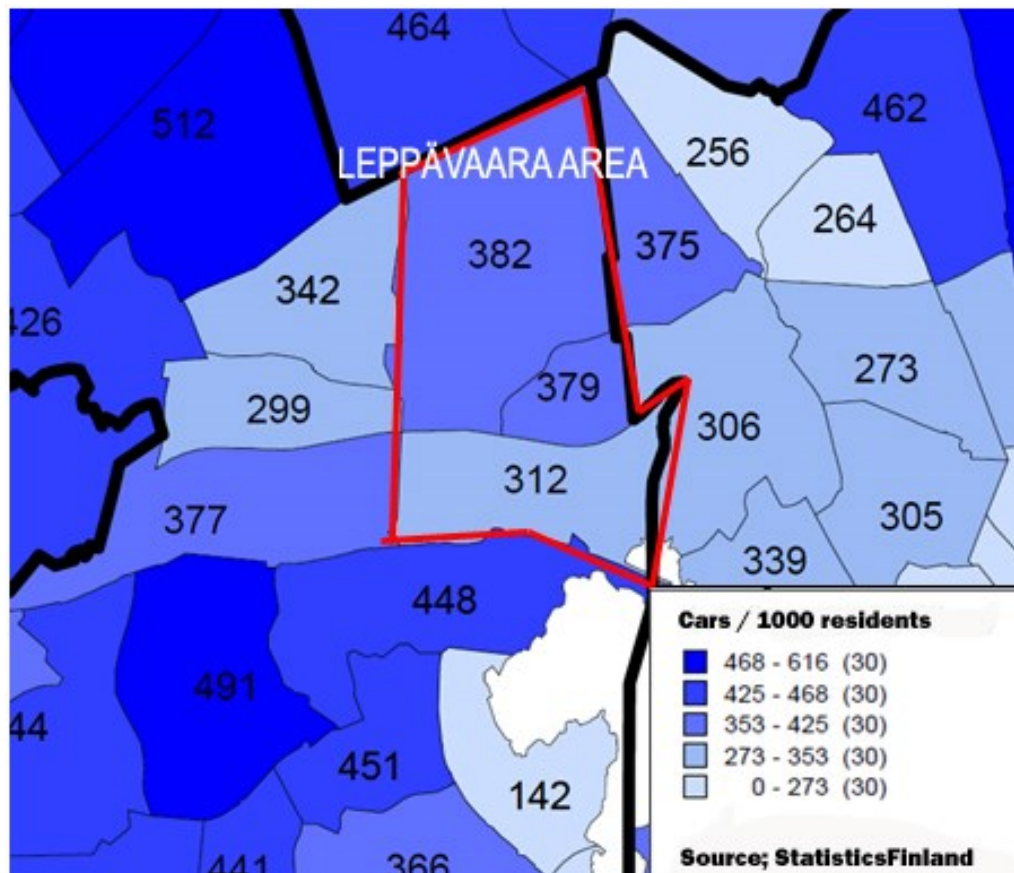


Figure 12. Car density in Leppävaara

In southern Leppävaara there are 312 cars per 1000 people. This is less than northern Leppävaara where density is about 380 cars per 1000 people. Car density is slightly higher than in Helsinki to the east of Leppävaara but lower than elsewhere in Espoo such as northern Espoo.

In 2012, when asked about how they felt about traffic flow in Leppävaara as part of the Transport Barometer, residents seemed to be very satisfied, with over 60% of respondents saying that traffic flows reasonably well or very well. This positive response was consistent with residents of other urban centres in Leppävaara who were also more than satisfied with traffic flow in their districts[54]

Commuters to Leppävaara

In the Greater Leppävaara area, there are over 30,000 jobs[56] and people commute to Leppävaara from across the HMA. Figure 13 illustrates the locations from which people travel to work in Leppävaara.

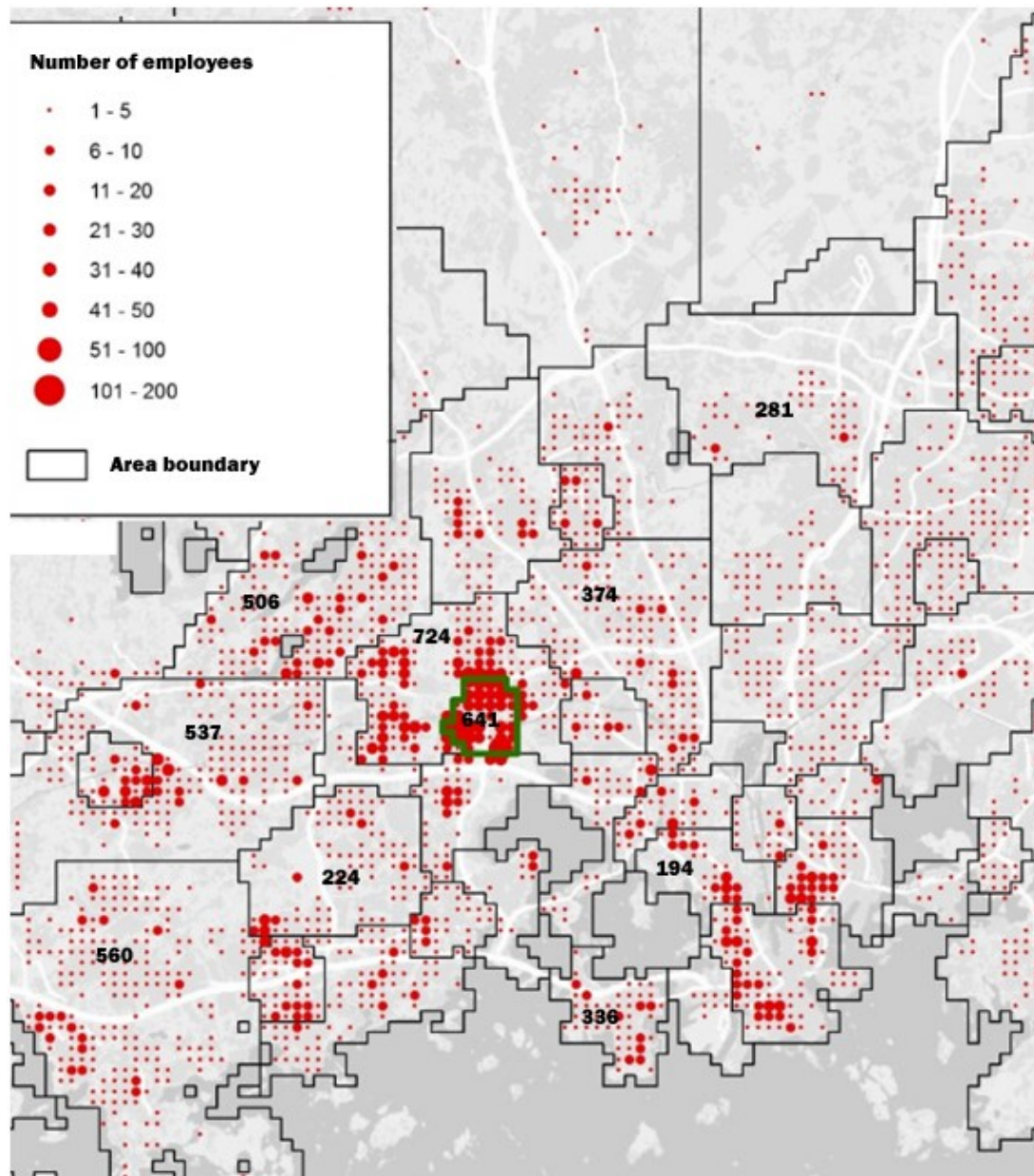


Figure 13. Places from where people come to work in Leppävaara (Source: Suomen ympäristökeskus, 2014[49], translated)

In particular, Kauklahti and Espoonlahti, both situated to the west of Leppävaara are important origin points, providing around 12% of all of commuters to Leppävaara. There are also significant numbers of commuters arriving from the Helsinki area, east of Leppävaara[49]. It is interesting to remember the accessibility zones at this point. For example, those who travel from Espoonlahti are coming from an area of reduced accessibility and therefore may have to use private car to get to Leppävaara.

Trips within Leppävaara

Of all trips taken in Leppävaara, the modal split between different transport modes is fairly even. As illustrated in Figure 14, the private car represents 45 % of all trips, public transport represents 29% and walking and cycling is equal to 25% of all trips[57].

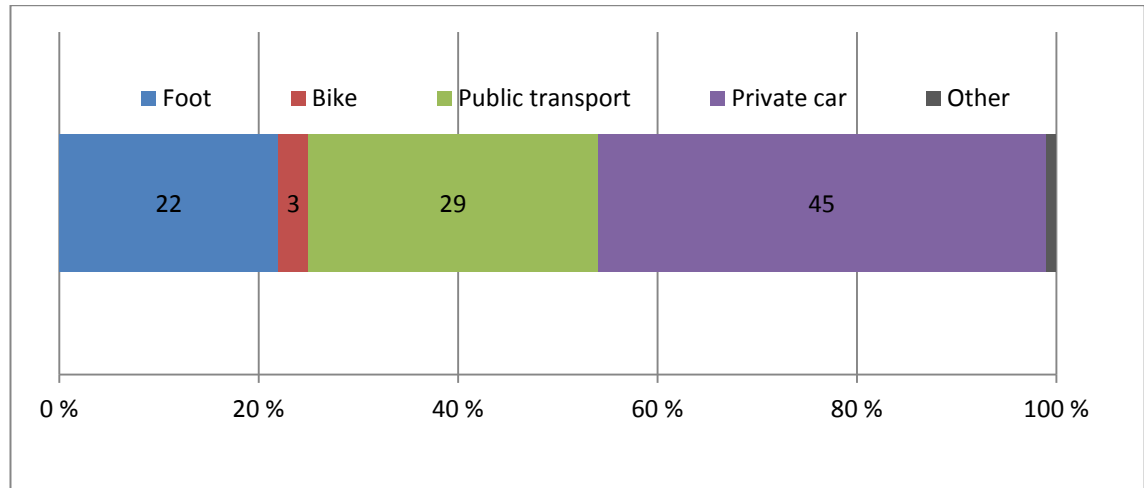


Figure 14. Modal split of journeys within the centre of Leppävaara (Source: adapted from Suomenympäristökeskus 2014[57])

This modal split falls within the average of subcentres within the HMA. At the urban area of Pasila for example, which is situated just a few kilometres north of the centre of Helsinki at a railway interchange, the private car has 27% of the modal share. In Matinkylä, in the City of Espoo, the private car takes up 52% of the modal split[57]. The public transport share of 29% in Leppävaara leaves it slightly behind other urban centres that have a metro connection, such as Itäkeskus (34% public transport), Herttoniemi (30%) and Vuosaari (34%)[57]. These areas are also within the Helsinki public transport zone, which means travel from these areas using public transport can be cheaper.

Most trips within Leppävaara are made up of work, shopping, and free-time, or recreational trips. Work trips take up 35% of all trips made within Leppävaara, shopping represents 20% of all trips, and free time is 24% of all trips. The remaining proportion of trips are for school visits and personal business. These are illustrated in Figure 15. The proportion of work trips in Leppävaara are slightly larger than at other similar centres within the HMA[57].

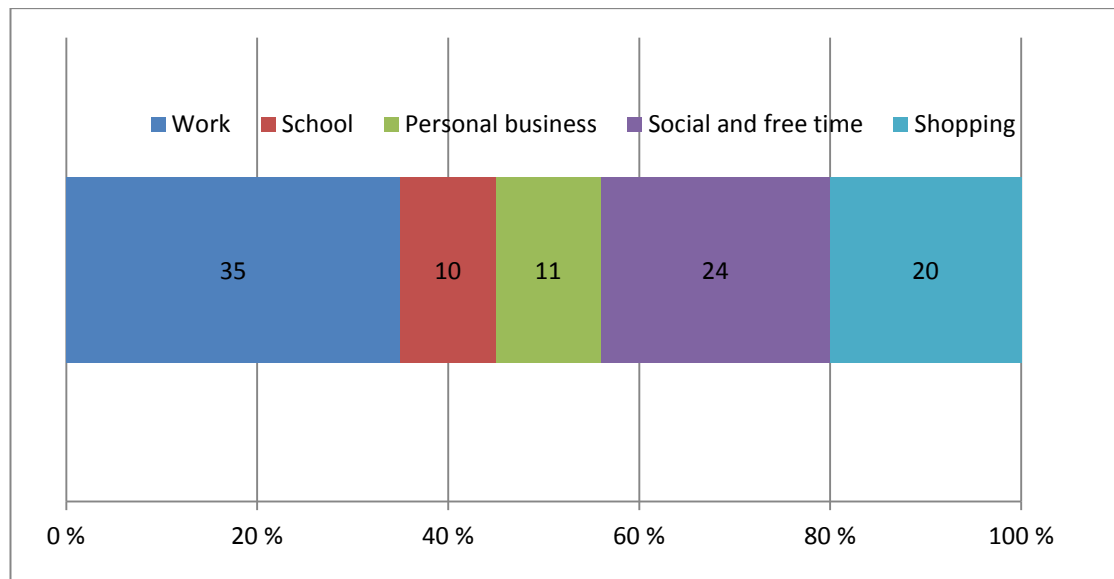


Figure 15. Purpose of trips within the Leppävaara area (Source: adapted from Suomen ympäristökeskus 2014[57])

In comparison to other urban centres within the HMA, Pasila has the highest proportion of work trips, with 51% of journeys made within Pasila being for work which is far more than the 35% of journeys made for work purposes in Leppävaara. This difference may be exaggerated however because in Pasila there is no shopping mall, unlike in Leppävaara. In Pasila just 10% of trips are made for shopping purposes but in Leppävaara the proportion is 20%.

4.2 Assessment of parking in Leppävaara

This section contains an analysis of the existing parking situation in Leppävaara, including an estimate count of parking spaces and a comparison with other cities. To begin with, there is a brief summary of previous relevant research conducted by the City of Espoo.

4.2.1 Previous research

It is useful to look at previous research relating to parking in Leppävaara. The research provides some initial clues as to existing parking capacity and how the parking situation is viewed by the public

Transport barometer

The Transport Barometer was a survey conducted by TNS Gallup Oy and commissioned by the City of Espoo. It was distributed to residents of Espoo in 2012 and aimed to find out what residents thought about the existing transport system. Of particular relevance to this research is the question related to parking opportunities, displayed in Figure 16.

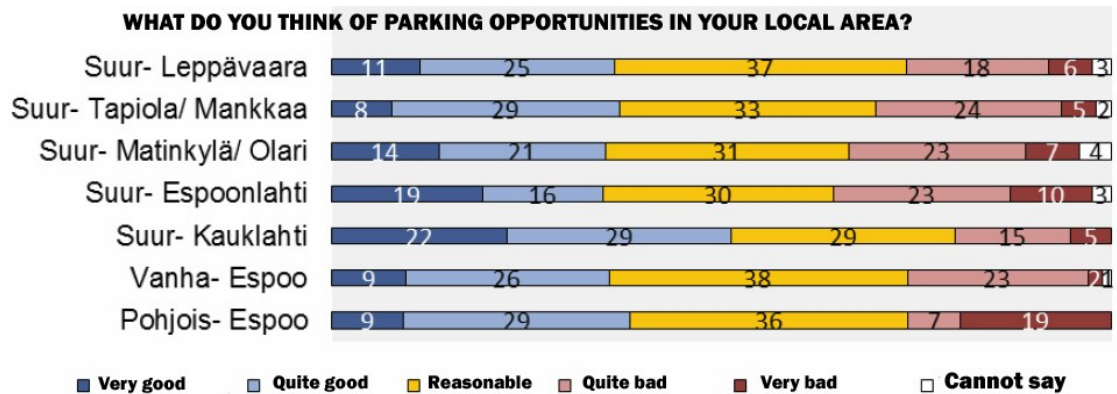


Figure 16. Responses to question about parking opportunities in different areas of Espoo. (Source: Valta and TNS Gallup Oy, 2012[54], translated)

Only 36% of residents feel that parking opportunities within the greater Leppävaara area are quite good or very good with 37% saying they are satisfactory. This leaves 24% who are of the opinion that parking opportunities in Leppävaara are poor, or very poor, and 3% who did not state their opinion[54]. Compared to other districts of the City of Espoo however, it seems that parking opportunities in Leppävaara are no better or worse than elsewhere, with the exception of Kauklahti, where people are more content with the parking situation.

Park and ride

The City of Espoo investigated the capacity and occupancy rate of the Leppävaara park and ride facility in 2014. There are 236 park and ride spaces subject to a small fee for daily use between 6am and 4pm. Outside of this time frame spaces are free for visitors to Sello shopping centre. On 27.2.2014 it was found that the car park was 90% full between 9am and 3pm, based on information from the pay machines. After this time, the park and ride facility began to empty. At 5pm there were 119 commuters remaining and 14 new customers to the parking centre (57%). Park and ride starts at about 6.30am and by 8am the park and ride facility is already at a 50% capacity.

The suggestion therefore, is that park and ride in Leppävaara is a popular facility during the day time and that perhaps more capacity is needed.

Seasonal impacts for on street parking and residential parking

Investigations into on street parking and residential areas of southern Leppävaara were carried out at different times of the year in 2010. The research found that occupancy rate and capacity of parking spaces varies significantly depending on the season. During the summer for example, many Finnish people spend long summer holidays away from the city. In the winter, people want to park their car indoors to protect against severely cold conditions. This means that the spring and autumn periods are often busiest for on street parking. The results of the research can be seen in Table 3.

Table 3. Occupancy rate of car parks in summer and winter, in south Leppävaara, 2010 (Source: City of Espoo 2010)

	Parking spaces	Cars counted		Difference	Summer Occupancy rate	Winter Occupancy rate
		Summer (20.05.2010)	Winter (14.12.2010)			
Residential underground car park	657	200	352	152	23 %	44 %
Residential multistorey car park	213	40	24	-16	5 %	3 %
Espoo on street parking	333	159	108	-51	18 %	14 %
Residential parking total	1203	399	484	-85		
Ruusutorppa school	60	33	48	15	4 %	6 %
Total spaces	1263	432	532	-100		

According to *Table 3* the occupancy rates are quite low. This is because cars were counted during the day time when many were away from work. The purpose of the research was not so much to find out the maximum occupancy rate of the car park, rather the difference between summer and winter.

Method and weaknesses

Parking spaces were counted using street view images, aerial photographs and in some instances with a site visit. If parking spaces were underground or in a multi-storey car park information regarding the number of parking spaces were obtained from architectural drawings provided with building permission applications, the websites of the owner of the facility (such as the Sello supermarket), and sometimes estimation was made on the basis of the zonal plans and associated minimum parking requirements. There are therefore, a number of opportunities for inaccuracy. Firstly, human error may have occurred when manually counting spaces. Secondly, photographs of some parking spaces may have been obscured. Third, data obtained from websites may be inaccurate. Fourth, buildings may not have been constructed as intended by architectural drawings, which means parking spaces indicated on a drawing may have been used for other purposes, or alternatively unofficial parking spaces may have been added over time due to demand.

Nonetheless, because the research is dealing with large numbers, and because inaccuracies may have led to both under and over counting at different times, the data related to parking spaces that has been generated is useful as an approximate estimation.

Data

In total, 15,417 parking spaces were counted within the centre of Leppävaara of which 1,636 are public and 13,781 are private. Of the 1,636 public spaces, 679 are located on street. The location of parking spaces are shown in Figure 18.

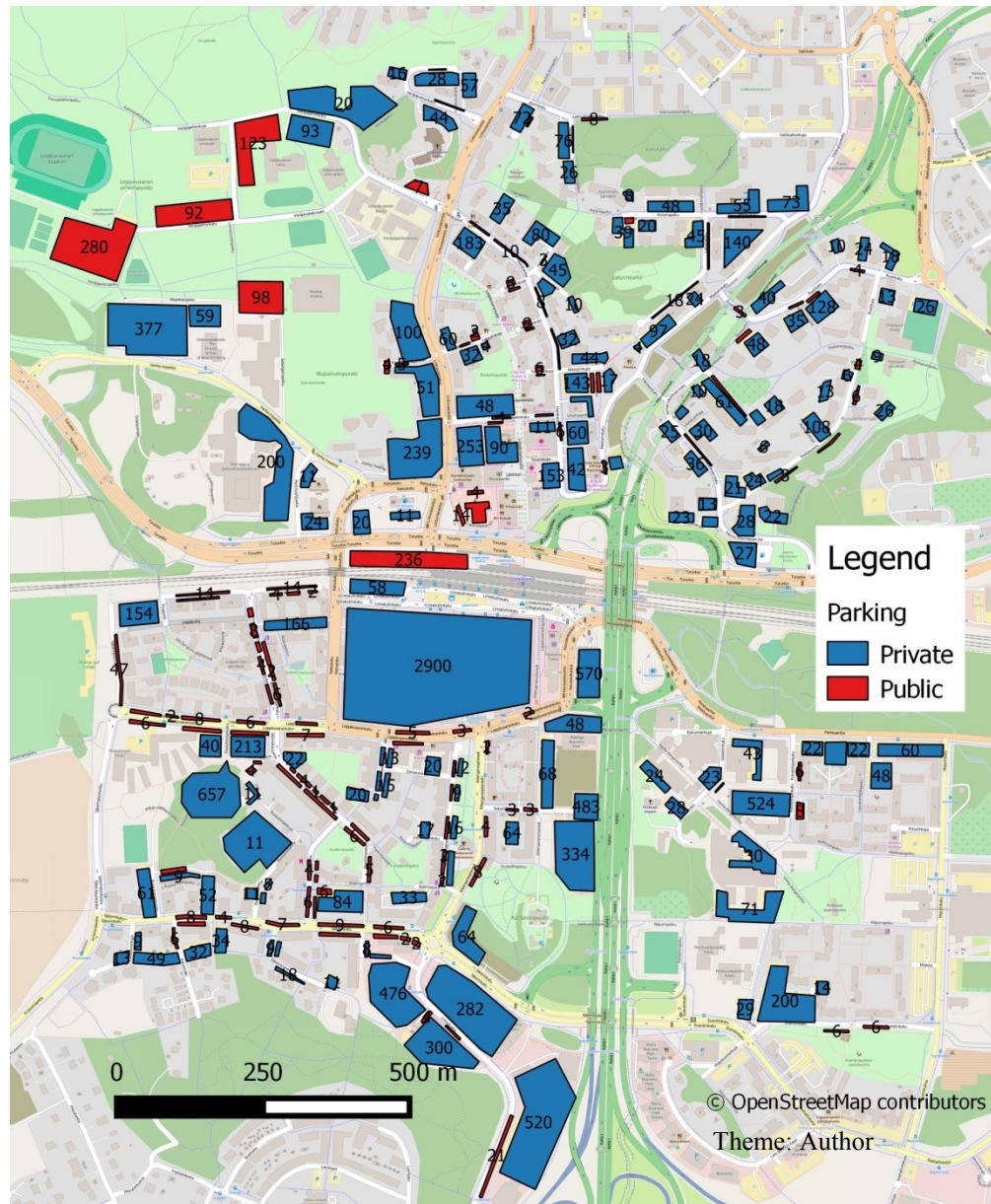


Figure 18. Location of public and private parking spaces in Leppävaara study area

Public parking spaces are sometimes subject to time restrictions. Time restrictions are usually only enforced however during the day time between around 8am and 6pm. Out of 1,636 public parking spaces:

- 79 have very short term time restrictions of between 10 - 30 minutes
- 175 have restrictions of 1 - 2 hours, 359 spaces are restricted for 3-4 hours
- 1,016 have no restriction, the majority of which are for public sports facilities or off street parking.
- There are seven spaces which are restricted for disabled users only.

Taking on street parking only into account, then the number of spaces for each time restrictions is as follows is as follows:

- 75 very short term (10 - 30 minutes),
- 88 short term (1 - 2 hours),
- 341 medium term (3 - 4 hours),
- 168 without restriction, and
- 7 spaces restricted to disabled users only.

Private spaces are usually intended for certain user groups although enforcement is the responsibility of the private landowner. Out of 13,781 private parking spaces:

- 3,536 are for commercial and business purposes,
- 5,275 are for residential purposes,
- 3,813 are for shops
- 1,157 are for services including schools, places of worship and recreation centres.

The different uses of parking spaces is shown in Figure 19. Time restrictions of public spaces are shown in Figure 20.

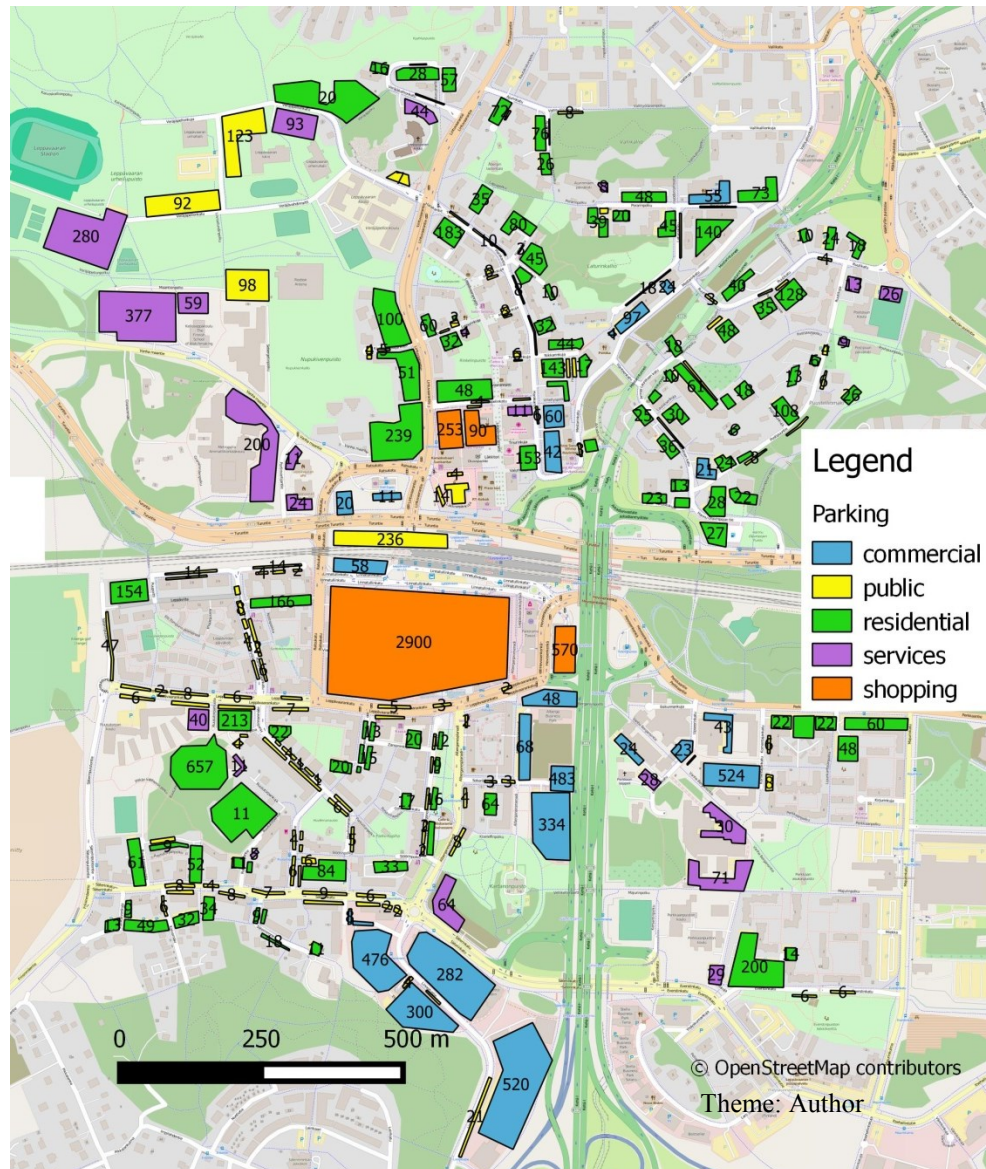


Figure 19. Purpose of parking spaces within Leppävaara study area

Unsurprisingly the majority of spaces for shopping purposes are located within the centre of Leppävaara where the shopping malls area situated. Parking for work and commercial purposes is usually organised into large parking facilities. The largest are located on the southern side of the study area. Residential parking is usually divided into smaller parking facilities. The exception is the underground car park in southern Leppävaara which has 657 parking spaces.

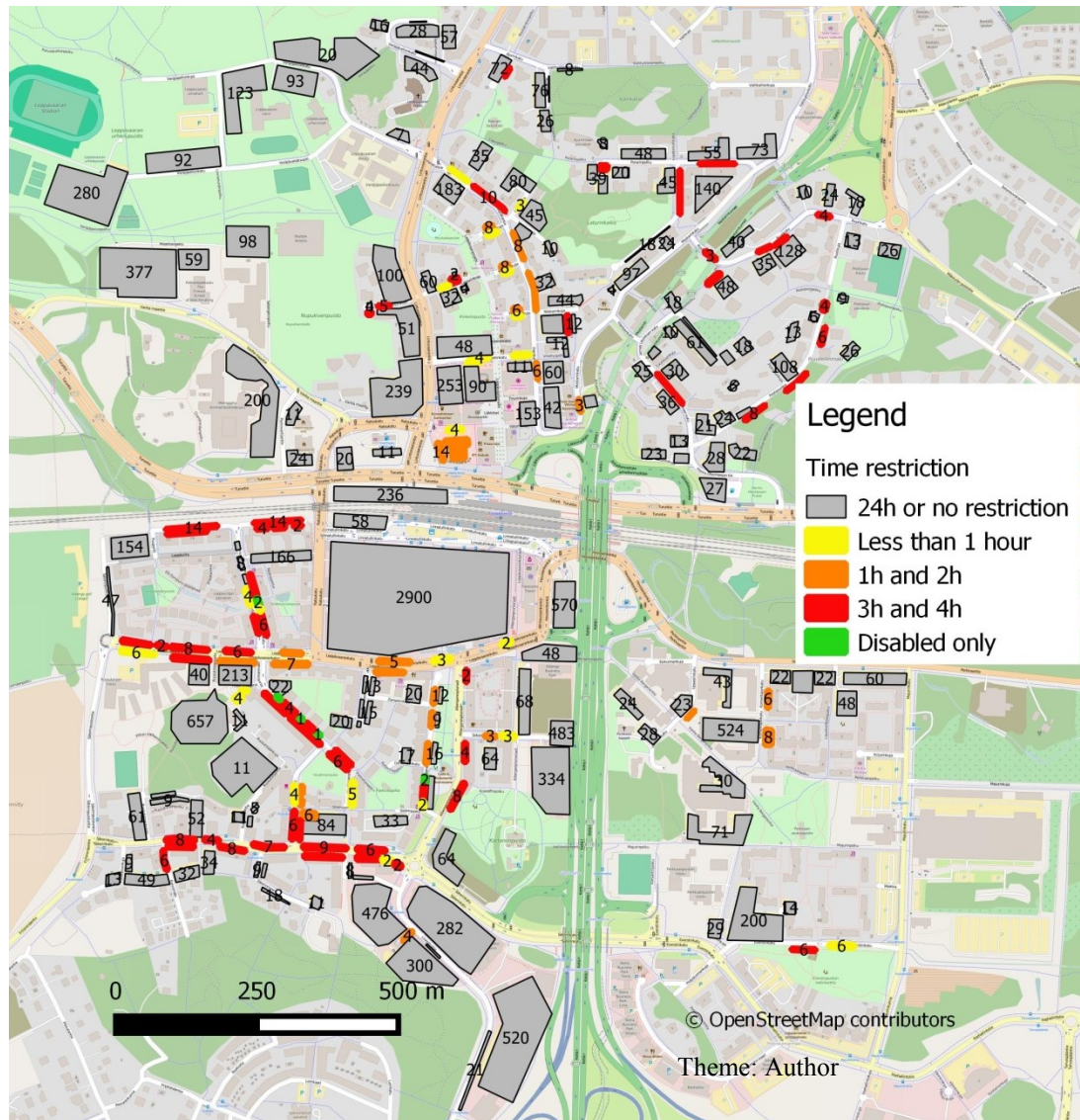


Figure 20. Time restrictions of public parking spaces in Leppävaara

Most parking spaces have restrictions of 3h or 4h. The map in Figure X1 indicates however, that a lot of the spaces with shorter term time restrictions seem to be located in the centre of Leppävaara, or near the pedestrianised street of northern Leppävaara.

In comparison with other world cities, the number of parking spaces in Leppävaara and the share of land that they would take up if they were laid out in a single car park is about average. Table 4 compares the amount of parking coverage in Leppävaara compared to major cities across the world. Also included in the table is the comparison of parking coverage in the two different zones of the dynamic parking scheme outlined in section 4.3.

Table 4. Comparison of parking coverage with Leppävaara and world cities. (Source for other city's figures: (Manville and Shoup 2005[7])

URBAN AREA	Land area (hectares)	Parking spaces	Parking spaces / hectare	Parking area in hectares	Parking coverage
Los Angeles, USA	408	107,441	263	331	81%
Leppävaara Zone A	50	6,505	130	20	40%
Frankfurt, Germany	240	29,487	123	91	38%
Canberra, Australia	329	39,558	120	122	37%
San Francis- co, USA	391	39,756	102	122	31%
Phoenix, USA	393	31,937	81	98	25%
Leppävaara (total)	193	14,247	73	43	22%
Copenhagen, Denmark	455	27,400	60	84	19%
Hong Kong	113	6,376	56	20	17%
Leppävaara Zone B	143	7,742	54	23	16%
Stockholm, Denmark	424	13,050	31	40	9%

Altogether, in the study area the number of parking spaces compared to land area equates to parking coverage of 22%. This means that if all parking spaces in Leppävaara were combined into one large surface car park, it would take up almost quarter of the land. Comparative figures can be found in Phoenix, USA and Copenhagen, Denmark. Los Angeles at the extreme end of the scale has a parking coverage of 81%[7]. Although eye-catching in terms of parking supply, this figure says more about how intensive land use is within the area. For example, in zone A of Leppävaara, where the Sello

shopping mall is located, parking coverage rises to 40%. This is largely because of the underground parking facilities used by the shopping mall. For comparison, parking coverage in zone B of Leppävaara drops to 16% and land use in zone B is not as dense as in zone A.

Research has found that car dependency of an urban area is related to the number of spaces for each job[7]. If an area has a high proportion of parking spaces for each job, then it is likely to have a higher modal share of car users. In this analysis Leppävaara is average in terms of car dependency. Table 5 shows available commercial parking spaces and unrestricted parking spaces in Leppävaara and the two zones of the dynamic parking scheme introduced in section 4.3 in comparison to other cities around the world.

Table 5. Number of parking spaces per job and share of private vehicles of the modal split in Leppävaara and other urban centres (Source for other city's jobs and parking space data: Manville Shoup, (2015)[7], Source for modal split data: ACT Government (2014) EPOMM (2015), The Transport Politic (2015), [58]–[60], Source for Leppävaara employment data: HSY SeutuCD)

URBAN AREA	Jobs	Jobs / hectare	Parking spaces / job	% car as Modal share	Number of commercial spaces + unrestricted public spaces
Canberra, Australia	22,521	68	1.76	85%	
Phoenix, USA	35,267	90	0.91	88%	
Los Angeles, USA	206,474	506	0.52	77%	
Leppävaara Zone B	6,483		0.51	45%	3333
Frankfurt, Germany	119,735	499	0.25	34%	
Leppävaara (Total)	16,286	84	0.25	45%	4173
Copenhagen, Denmark	122,770	270	0.22	33%	
San Francisco, USA	291,036	744	0.14	46%	
Stockholm, Sweden	111,233	262	0.12	47%	
Leppävaara Zone A	9,803		0.08	45%	840
Hong Kong	193,520	1,713	0.03	11%	

Cities with the highest share of private car users tend to have more parking spaces per job. Phoenix, USA for example has about 0.91 parking spaces for each job and the private car takes up 88% of the modal share[60]. Similarly, Canberra in Australia has 1.76 parking spaces for each job and it is also car dependent, with the car representing 85% of the modal share[58]. At the other end of the scale, Copenhagen has just 0.22 parking spaces per job and the private car is only 33% of the modal share[59]. When conducting the same analysis for Leppävaara, parking spaces for residential or non-business use

were discounted because they were not able to be used by commuters. This meant that in the whole of Leppävaara there were about 0.25 parking spaces per job. In the centre of Leppävaara this was even lower at 0.08 spaces per job and outside the figure increased to 0.51 spaces per job.

The simple message of this analysis is that if the number of spaces per job is reduced, then the number of commuters arriving by private car will reduce too leading to the private car having a lower share of the modal split. Of course alternative sustainable modes of transport should be available to reduce reliance on the private car in this way. Such benefits are also only likely if an area therefore suffers congestion problems because of work traffic. In the case of Leppävaara, it does not appear to be the case that work traffic causes severe congestion in the area.

To follow up the analysis of parking spaces compared to number of jobs, a similar analysis was conducted for residential parking spaces. There were no comparable figures from other urban areas and so in this case, Leppävaara is examined alone. The number of parking spaces per resident and number of cars per residential space is displayed in Table 6. This analysis does not include off street parking spaces.

Table 6. Number of residential parking spaces per resident and per car in Leppävaara (Source for population information: HSY SeutuCD)

	<i>Number of spaces</i>	<i>Number of residents</i>	<i>Number of spaces / resident</i>	<i>Estimated number of cars (based on density of 350 cars / 1000 residents)</i>	<i>Number of spaces / car</i>	<i>Surplus or deficit</i>
Leppävaara zone A	1265	4672	0.27	1636	0.77	-371
Leppävaara Zone B	3765	7303	0.52	2556	1.47	1209
Leppävaara altogether	5030	11975	0.42	4192	1.19	838

The car density for this analysis was 350 cars per 1000 residents. This was an approximate average between the densities of car ownership presented in Figure 12.

Altogether, in the study area there were 0.42 parking spaces per resident. However, not all residents own a car. Comparing the figures of car density to the number of spaces in Leppävaara then for residential uses there are 1.19 parking spaces per car. If all cars were parked in Leppävaara, the occupancy rate would be about 85%, which has been suggested as the ideal, most efficient occupancy rate for car parks[18]. Of course, it is not true however, that the figure of 1.19 parking spaces per car is distributed evenly across the whole Leppävaara area. In the central zone of the dynamic parking scheme introduced in section 4.3 there are only 0.77 parking spaces per car, whilst in the outer zone of the dynamic parking scheme there are 1.47 parking spaces per car (these figures may however be misleading, as some properties within the central zone are able to use the large underground residential car park is mostly located in the outer zone of the dynamic parking scheme). In addition, residents may be looking for spaces located within the immediate vicinity of their home, meaning that even though there are more spaces

than there are cars for residents, the location and quality of the parking space may not always be satisfactory.

As a further final analysis of residential parking spaces in Leppävaara, a comparison was made between number of spaces per resident and number of spaces per car for north and south Leppävaara, using the railway line as a boundary. The results can be seen in Table 7.

Table 7. Number of residential spaces per resident and per car in north and south Leppävaara

	<i>Number of spaces</i>	<i>Number of residents</i>	<i>Number of spaces / resident</i>	<i>Estimated number of cars (based on density of 350 cars / 1000 residents)</i>	<i>Number of spaces / car</i>	<i>Surplus or deficit</i>
North	2803	4851	0.58	1698	1.65	1105
South	2335	5865	0.39	2053	1.13	

According to this analysis, residents north of the railway line in Leppävaara have 1.65 spaces per car which is more than residents of south Leppävaara who have 1.13 spaces per car. This would indicate that the parking situation in north Leppävaara is better for residents than it is in south Leppävaara.

In theory, if this analysis shows that workers and residents have a sufficient amount of parking spaces, then the on street parking spaces should be used primarily by visitors. At this point it is worth remembering the results of the Transport Barometer in 2012 in Figure 16 where only 20% of respondents said they were not happy with the parking situation in Leppävaara. Based on these figures it can perhaps be concluded that the parking system is sufficient and functional.

However, the concept of parking fees and a dynamic parking scheme is still a relevant consideration because they may help to improve sustainability and development further, and represent a fairer way of collecting money for the maintenance of the parking space. It is hoped that in the City of Espoo a database can be created to calculate the number of parking spaces in the municipality. In this way, management and evaluation of parking schemes would be easier to achieve[3].

4.3 Proposed dynamic parking scheme

The proposed dynamic parking scheme that will be presented as part of the survey is comprised of geographical and temporal variables. Although smart parking technology and improved information communications allow for a more complex dynamic model, to keep the survey manageable and understandable it was decided to proceed with a simple model. The dynamic parking proposal is therefore comprised of just two geographical zones and two time variables.

The proposed scheme is also by no means a perfect solution. It is intended to produce results from the survey as to how people would react to the scheme which could then be applied to different versions of the parking proposal.

4.3.1 Geographical variables

The area of Leppävaara is divided into two zones for the dynamic parking scheme. The zones can be seen in Figure 21.

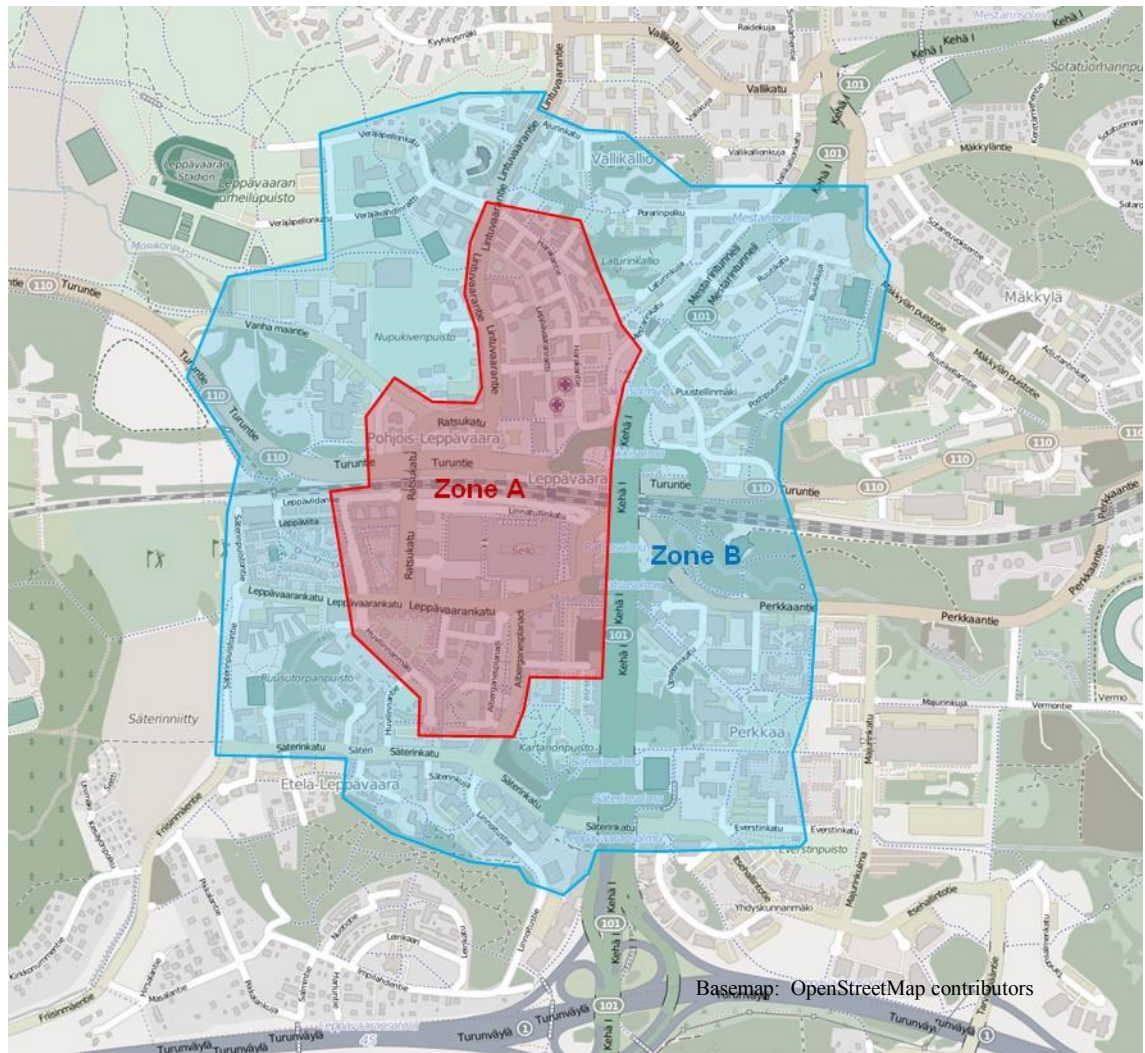


Figure 21. Proposed boundaries of parking zones in dynamic parking scheme

In defining the geographical scope of the parking zones, the barrier effect was taken into account as well as land use and accessibility considerations such as walking and cycling links and access to public transport. In addition, some of the lessons learnt from the parking analysis in section 4.2 were applied.

The Sello shopping mall and the public transport interchange comprising of the train and bus station are situated at the centre of zone A. It is bordered to the east by the Kehä I motorway which forms a significant barrier and to the northwest by Linturvaarantie, which also forms a barrier between the centre of Leppävaara and residential areas. The pedestrianised street, Lintuvaaranraitti improves accessibility and stretches Zone A towards the north. South of the railway line, Zone A stretches along the pleasant boulevard named Albergan Esplanadi towards Säterinkatu where land use changes from residential to commercial offices.

The western border of Zone B is defined by the extent of land use in the Leppävaara area. The southern border then encompasses the commercial offices in the south of Leppävaara. The eastern extent of Zone B reaches over the Kehä I ring road motorway into the residential areas of Perkkää and Mäkkylä. In the north, zone B takes in the church, schools, and sports centre.

The zones cover some of the busiest roads within the area and also important and popular land uses. Local bus transport services generally move in a north – south direction which also stretches the shape of the zone along this axis. Figure 22 compares the suggested parking zones to accessibility zones. There is some correlation between level of accessibility, and extent of the parking zones.

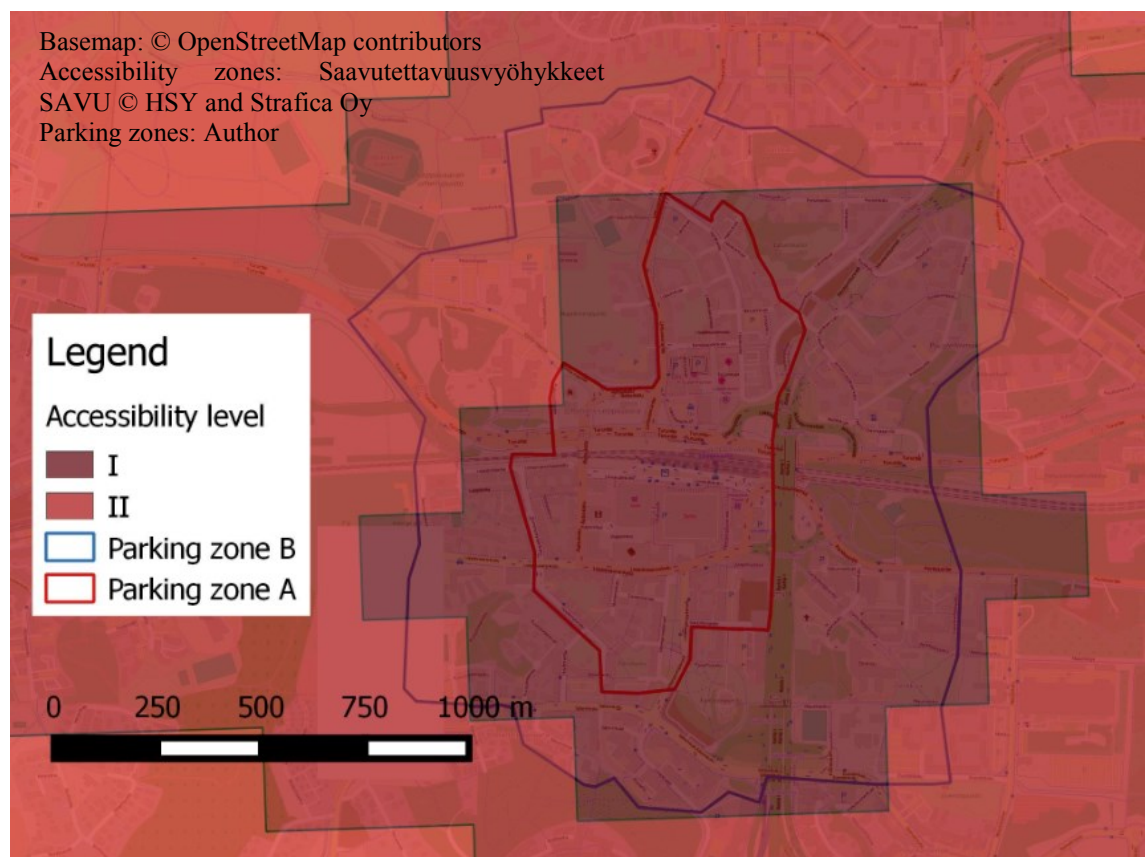


Figure 22. Comparison of parking zones and accessibility zones

4.3.2 Temporal variables

The two temporal variables were peak and off-peak with peak hours were between 7am – 9am and 4pm – 6pm. These times were based on traffic volume data procured from the City of Espoo.

4.3.3 Pricing scheme

The pricing scheme took into account the price of a public transport ticket, and the prices of parking elsewhere within the HMA. The final tariff scheme is displayed in Table 8.

Table 8. Proposed tariff for the dynamic parking scheme

		<i>Geographical variable</i>	
		<i>Zone A</i>	<i>Zone B</i>
<i>Temporal variable</i>	<i>Peak</i>	4€/hour	3€/hour
	<i>Off peak</i>	3€/hour	2€/hour

The highest price for parking compares well to the cost of a single public transport ticket which is either 3€ or 5€ depending on whether the train or bus journey is made from within Espoo or from Helsinki[61]. Similarly, the price of parking in the centre of Helsinki is 4€ an hour[62]. Although Leppävaara cannot be compared to Helsinki in terms of shops and services, the price in Leppävaara is taking peak hour into consideration.

The lower price of 2€ compares to the cost of parking in another urban centre of Espoo, Tapiola which is 2€/hour at weekends[63].

Nonetheless the suggested tariff scheme could be seen as expensive, considering that now there are no charges for parking collected. For the questionnaire however, it is hoped that the expensive tariff scheme may encourage the respondent to think carefully about the sort of action they would take to avoid paying fees if necessary.

5 Survey setup and data collection

This chapter explains first some of the decisions and justifications made when the survey was created before detailing how the data was collected.

5.1 Survey setup

So that the survey could reach a wider audience, it was decided to conduct an online survey. Whilst this meant that only those who were computer literate would be able to respond, high computer literacy rates in Finland[64] indicated that this problem would be minimal. The main aim of the survey would be to find out how people would react to a dynamic parking scheme as proposed in section 4.3 whilst also gauging opinions on other parking preferences, such as preferred payment method. Principles for web questionnaires were taken into account[65] and aspects of the survey structure and question wording were discussed with experts interviewed in chapter 3.2.


The survey was anonymous and carried no risk for participants. Respondents provided their email address only if they wanted to enter into a prize draw as reward for entering the survey.

5.1.1 Survey software

The survey was constructed using Limesurvey[66] and hosted using Limeservice[67]. This software was open source and had features and capabilities necessary to produce the survey, including randomisation of questions and question groups.

5.1.2 Opening page

A blog page was created to hold the link to the survey. The blog page had a URL, in this case <http://blogs.aalto.fi/parking>, which would be easier for respondents to remember than the URL provided by Limeservice. The opening page also provided opportunity to inform the respondent how long the survey will take, the purpose of the survey, and the reward or motivation for completing the survey. Screenshots of the holding page can be seen in Figure 23.


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Google™ Custom Search

[Log in](#) | [Create your blog](#) | [Help](#)

feed

Tervetuloa! – Welcome!
 24.04.2015




Figure 23. Screenshots from the survey holding page

The intention was for this opening welcome page to be motivational and informative in accordance with Dillman's principles on web surveys[65].

Two links were provided from the opening page, one in Finnish and one in English, depending on the language choice of the respondent.

5.1.3 Language choice

The survey was conducted in English and Finnish. The national languages of Finland are Finnish and Swedish, however the number of Swedish speakers in Espoo is low, at just over 5% of the total population[45]. Swedish speakers are often bilingual, with Finnish as their other language. The 5% of the population that speak a different languages than Finnish or Swedish[45] normally use English as a second language. Therefore it was decided to conduct the survey in English too.

5.1.4 Increasing motivation for participation

As motivation for completing the survey, a prize draw was set up in which all respondents had chance to win one of two pairs of cinema tickets. The draw took place on 18th June 2015 and the winners were directly informed by email.

5.1.5 Presentation

In terms of presentation, the chosen font, colour scheme and graphics were simple so that it would not place unreasonable demands on the respondent's computer hardware. A graphical indicator was also used to indicate how far the respondent had progressed through the survey. Instructions were provided for respondents as to what was expected and how to answer each question. These techniques were in accordance with recommendations for web survey design[65].

5.1.6 Survey structure

The structure of the survey is illustrated in Figure 24. The aim was for the survey to be as simple as possible and so it was divided into five shorter sections. The first part requested basic demographic information that would be useful in the analysis process, the second and third parts identified aspects of the respondents' existing travelling behav-

iour, such as how often they visit Leppävaara for different reasons, and by which transport mode. The fourth part was a stated preference question section in which respondents were asked to imagine a situation in which parking fees had been implemented and suggest how they would react to parking fees under various different scenarios and purposes. The final part of the survey provided opportunity for the respondent to comment freely upon parking in general, suggested parking fees, and the questionnaire itself.

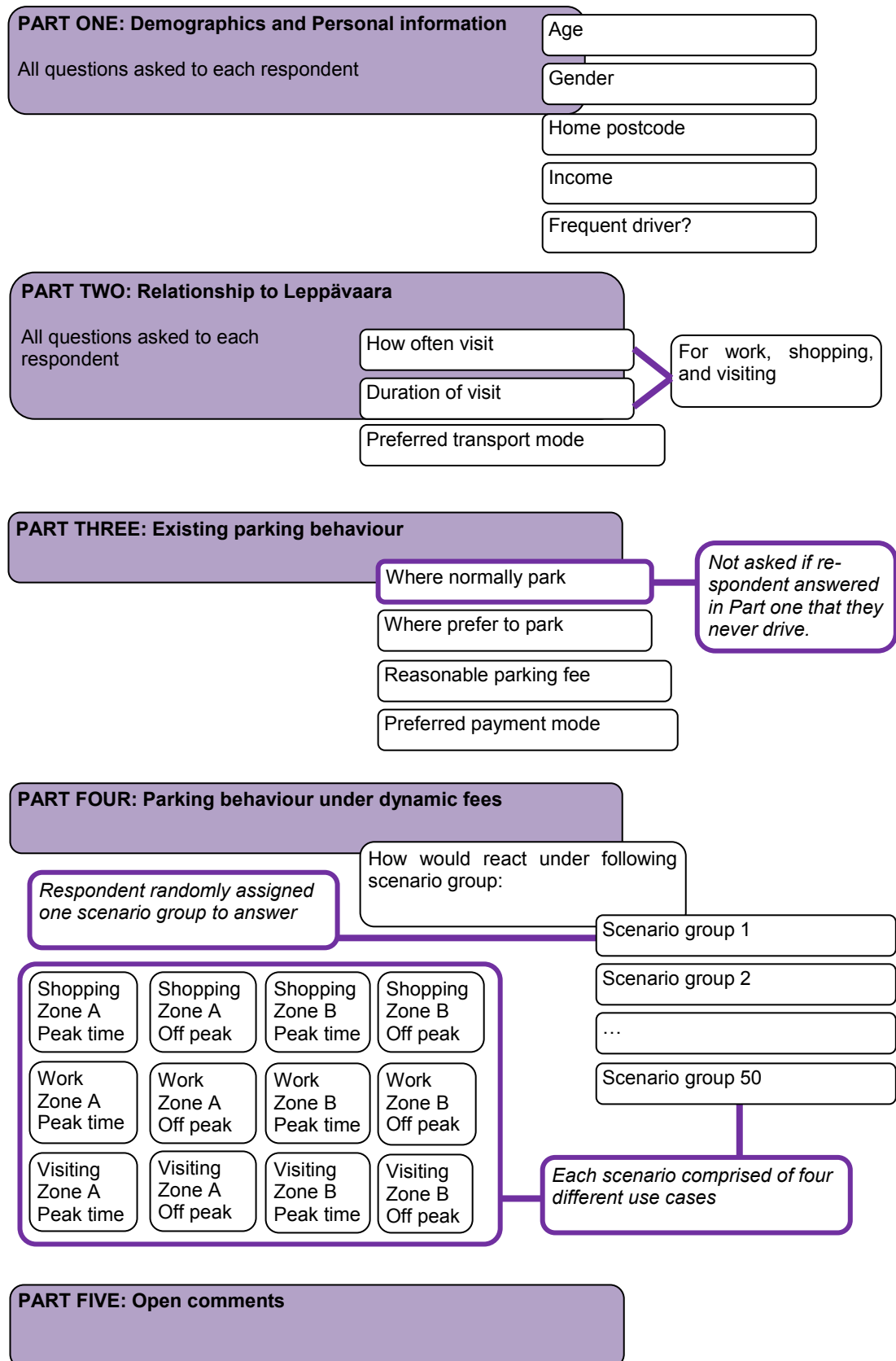


Figure 24. Survey structure

5.1.7 Questions

In this section, this thesis will look in more detail at the questions and some of the decisions made when designing the survey.

5.1.7.1 Demographics

It is recommended that the first question set should be visible on the screen without scrolling and should be simple and easy for the respondent to answer[65]. The demographic questions were fairly easy to answer, although they did not quite fit on the page without scrolling as recommended in guidelines.

The first question of part one asked the age of the respondent. This was a multiple choice question. The age ranges were grouped into sets of 10 years starting from the range 18-27 and ending at 68+. The legal driving age in Finland is 18 and 68 is the retirement age. The second question was a multiple choice gender question, with ‘Male’, ‘Female’ and ‘Other’ options available. See Figure 25.

The screenshot displays the LimeSurvey interface for 'Aalto University Master Thesis Research'. At the top, there is a LimeSurvey logo, a progress bar at 0%, and a language dropdown menu set to 'English'. Below this, the section is titled 'PART ONE: Personal information'. The first question is 'Age:', with the instruction 'Choose one of the following answers'. The options are radio buttons for '18-27', '28-37', '38-47', '48-57', '58-67', '68+', and 'No answer' (which is selected). The second question is 'Gender:', also with the instruction 'Choose one of the following answers'. The options are radio buttons for 'Male', 'Female', 'Other', and 'No answer' (which is selected).

Figure 25. Age and gender questions from the survey

The third question asked for home postcode and the answer had to be typed manually. The fourth question of part one was a multiple choice question which asked for gross household monthly income. Salary in Finland is usually calculated on a monthly basis and it would be easier for respondents to answer according to monthly salary than annual salary. The salary ranges were grouped into sets of 2,000€, starting at less than 2,000€ a month and ending at over 10,000€ a month. The final question of part one was a multiple choice question about how often the respondent drove a car. The choices available to answer this question were: ‘Never’, ‘A few times a year’, ‘About once a month’, ‘About once a week’, ‘A few times a week’, and ‘Every day’. See Figure 26.

Home postcode:
Only numbers may be entered in this field.

Approximate monthly household income:
Choose one of the following answers

- ☐ Less than 2000 € / month
- ☐ 2001 - 4000 € / month
- ☐ 4001 - 6000 € / month
- ☐ 6001 - 8000 € / month
- ☐ 8001 - 10 000 € / month
- ☐ More than 10 000 € / month
- ☒ No answer

* How often do you drive a car
Choose one of the following answers

- ☐ Never
- ☐ A few times a year
- ☐ About once a month
- ☐ About once a week
- ☐ A few times a week
- ☐ Every day

Exit and clear survey Resume later ◀ Previous Next ▶

Figure 26. Postcode, income, and frequency of driving questions from the survey

The question asking how often the respondent drives was mandatory, because the display of a later question was depended on this answer.

5.1.7.2 Relationship to Leppävaara

In the introduction to the questions in part two of the survey there was a map of Leppävaara which defined the geographical scope of the area in question. As indicated in Figure 27, the background map was taken from OpenStreetMap[68] and took in a large area so that respondents could orientate easier. It was also explained that if a respondent lived within the Leppävaara area as shown on the map, they could answer the questions according to if they were making a trip within Leppävaara and not to Leppävaara as expressed in the questions.

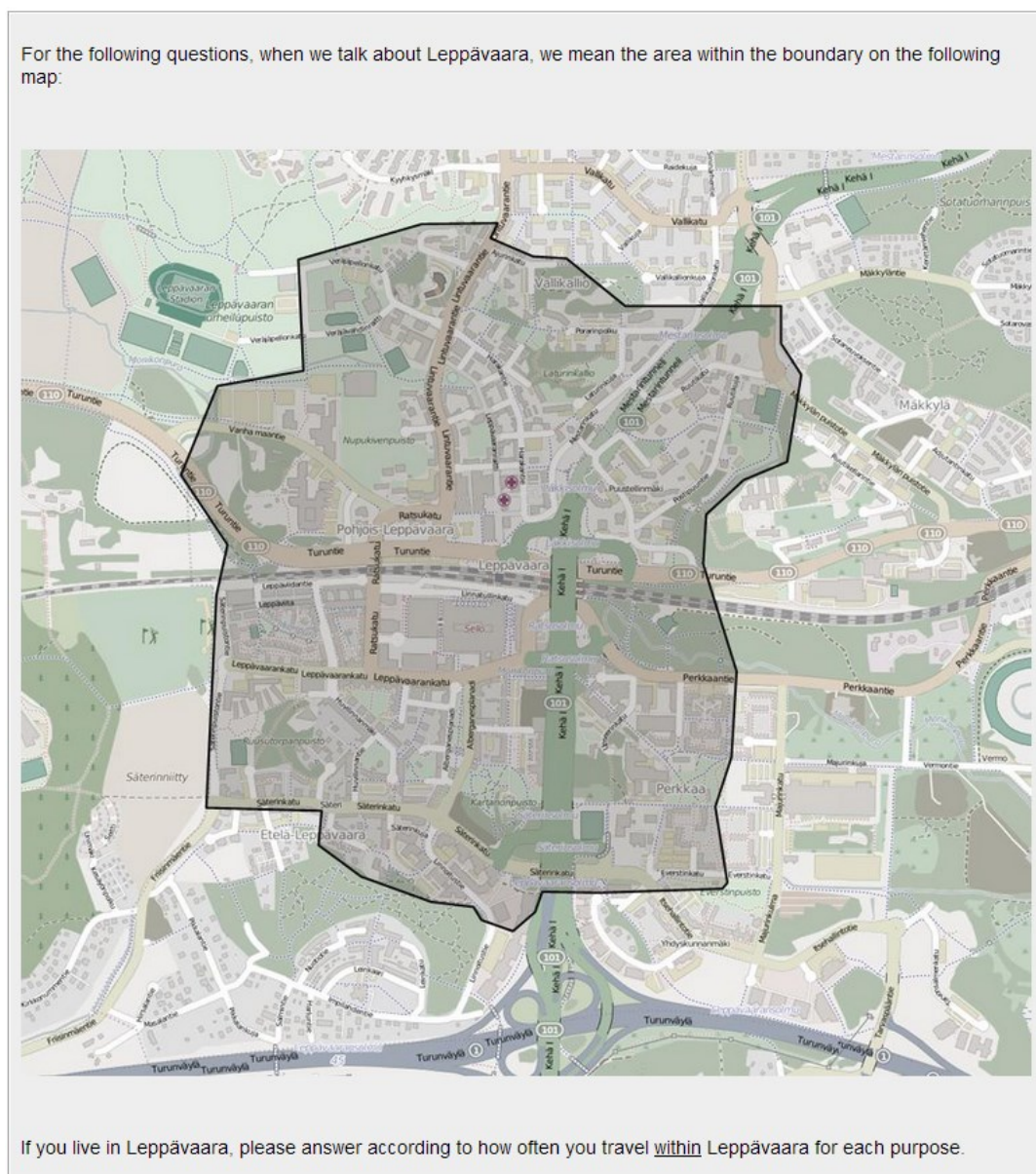


Figure 27. Introduction to questions group two from the survey

The first question of part two asked how often the respondent visited Leppävaara for work, shopping, and social purposes. Although there are many other reasons why someone might want to visit Leppävaara, including recreation, visiting schools and libraries, or medical appointments, to keep the survey simple it was decided to focus on just three main trip purposes. Work, shopping, and social visits were therefore the three trip purposes that were used throughout the questionnaire because it was felt they were the most important. In addition, it was felt that visiting for social purposes shared similar characteristics with other reasons why someone might want to visit Leppävaara. For example, visiting friends, medical appointments, and recreational activities are all short term activities that do not involve carrying heavy goods or equipment. To further clarify in the questionnaire, it was explained that social purposes comprised of visiting friends or recreation. The question was arranged into a matrix format. Options for frequency were: Never, a few times a year, a few times a month, 1 -3 times a week, 4 -6 times a week, at least once a day.

The second question enquired about duration of visit for each aforementioned purpose. It was not possible to restrict this question so that if someone answered that they never visited Leppävaara to go shopping for example, they would not have to answer how long they spend going shopping in the next question. Because of this, the first option for duration was 'I do not visit Leppävaara for this reason'. Other options were: 'Less than 1 hour', 'Between 1 – 4 hours', 'Between 4 – 8 hours', and more than 8 hours. See Figure 28.

✖

For each of the following reasons, how often do you visit Leppävaara?

Select one option for each row

	Never	A few times a year	A few times a month	1 - 3 times a week	4 - 6 times a week	At least once a day
Work or business purposes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Shopping	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Social reasons, such as visiting friends, or recreation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

✖

When you visit Leppävaara for the following reasons, how long does your visit normally last?

Select one option for each row

	I don't visit Leppävaara for this reason	Less than 1 hour	Between 1 - 4 hours	Between 4 - 8 hours	More than 8 hours
Work or business purposes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Shopping	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Social reasons, such as visiting friends, or recreation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 28. Questions regarding travel behaviour from the survey

These questions were mandatory because the information obtained would be needed during the analysis stage.

Finally it was asked which transport mode was used when visiting for each purpose. The available transport modes were car, bus, train, bike, walking. The respondent could select more than one option for each purpose because it is likely that one trip involves more than one mode of transport. This question is displayed in Figure 29.

When you visit Leppävaara for the following reasons, what form(s) of transport do you mostly use (You may select more than one option per row):

	Car	Bus	Train	Bike	Walk
Work or business purposes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shopping	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Social reasons, such as visiting friends, or recreation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Exit and clear survey Resume later ◀ Previous Next ▶

Figure 29. Question regarding transport modes from the survey

5.1.7.3 Parking behaviour


Part three investigated parking behaviour and was partly designed to match similar questions asked to respondents in the City of Helsinki in 2014.

The first question asked where respondents normally park when they visit Leppävaara for various purposes. The question was set up in a matrix format, as can be seen in Figure 30, and was not asked to those respondents who had answered in part one that they never drive a car. The equation used in the survey software, to ensure that non drivers were not asked the question was:

```
((HowOftenDrive.NAOK == "A2" or HowOftenDrive.NAOK == "A3" or HowOftenDrive.NAOK == "A4" or HowOftenDrive.NAOK == "A5" or HowOftenDrive.NAOK == "A6"))
```

On the other hand everyone was asked the second question, which enquired where respondents would prefer to park, if they had a choice. Non-drivers were able to answer this question so that this could later be analysed in terms of differences between parking preferences of non-drivers and those who drive regularly. The choices for this question were 'on street' or 'off street'. See Figure 30.

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English ▾

PART THREE: Parking behaviour

Even if you don't normally drive, we're still interested in your thoughts on the following questions!

If you visit Leppävaara by car, where do you normally park

	On street parking	Off street car park or parking facility	No answer
When visiting for work or business purposes	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
When shopping	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
When visiting for social or recreational purposes	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

Where would you prefer to park?

Even if you don't drive, we're interested in what you think

Choose one of the following answers

☐ On street
☐ Off street
☒ No answer

Figure 30. Questions regarding parking behaviour from the survey

The third question, shown in Figure 31, was a multiple choice about how respondents would like to pay for parking. The options provided were 'Coins', 'Card', 'Mobile Application', 'Other'. These options were consistent with options offered in the study in Helsinki.

The final question was a multiple choice set regarding what respondents thought was a reasonable price for parking. The options were divided into ranges of 1 euro, starting at 0 – 1€ and ending at 7,01€ - 8€. The last option was set at a high price, being twice that of the hourly parking charge in the centre of Helsinki. This was so that respondents had a broad range to choose from without automatically picking the highest variable. See Figure 31.

How would you prefer to pay for parking?

Choose one of the following answers

- ☐ Credit / Debit card
- ☐ Mobile application
- ☐ Coins
- ☐ Other (please state):
- ☒ No answer

* What is a reasonable hourly cost for parking in your opinion?

Choose one of the following answers

- ☐ 0 - 1 € / hour
- ☐ 1,01 - 2 € / hour
- ☐ 2,01 - 3 € / hour
- ☐ 3,01 - 4 € / hour
- ☐ 4,01 - 5 € / hour
- ☐ 5,01 - 6 € / hour
- ☐ 6,01 - 7 € / hour
- ☐ 7,01 - 8 € / hour

Exit and clear survey

Resume later

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Figure 31. Preferred payment method and reasonable cost of parking questions from the survey

5.1.7.4 Parking scenarios

Part four of the survey contained important questions related to parking behaviour under the dynamic parking scheme, taking parking location, parking time, and trip purpose into account. The price of the parking scheme was influenced by two geographical zones and two time periods. In addition, three different purposes for visiting Leppävaara had been identified, namely shopping, work, and visiting or recreation. This created a total of twelve different combinations which were made into scenarios for which the respondent could react to. Examples of different scenarios, and the variables which create them are illustrated in Figure 32.

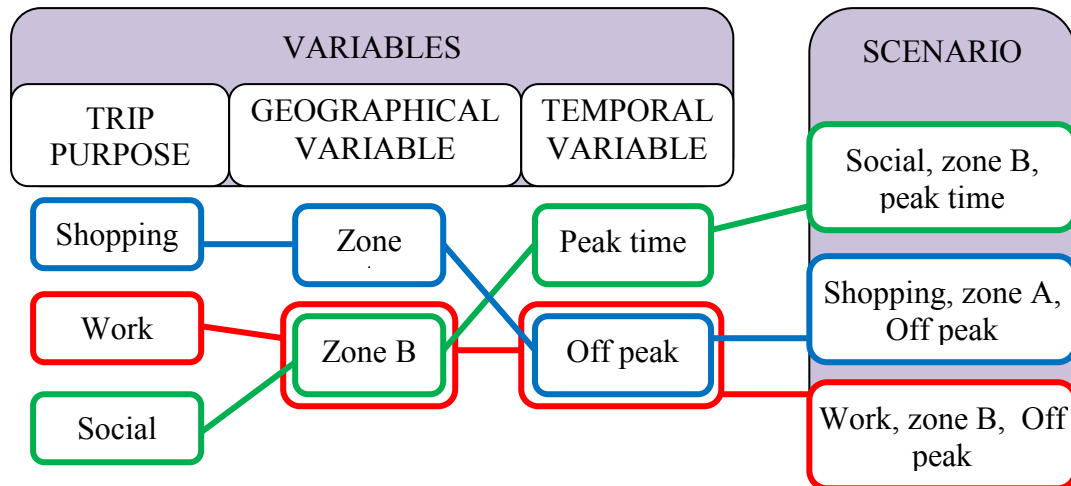


Figure 32. Variables that combine to make up scenarios and examples of three scenarios. There were 12 scenarios altogether

It was felt that 12 scenario based questions would be too demanding for a single respondent to answer and to simplify the questionnaire the 12 scenarios were divided into 50 groups of four scenarios. A scenario might be for example: Shopping, Zone A, Peak time or Shopping, Zone B, Off peak. Of these 50 groups, the respondent was assigned a random set of four scenarios based on a random number which had been automatically generated as a hidden question at the beginning of the survey. The random number was generated using the code for the survey software:

```
{rand(1,50)}
```

Each of the 50 scenario question groups were only asked if the random number selected at the beginning of the process matched the number of the question group. For example, question group 10 was only asked if random number was equal to 10 using the survey software code:

```
Relevance: (Randno.NAOK == "10"))
```

In this way the respondent was assigned a group which had four of the 12 scenarios available rather than having to respond to all 12 possible combinations.

The combination of scenarios was based on a design to optimise the D-efficiency, which represents the average of the variance. In the design of the question groups the D-efficiency was 100 meaning that the design was balanced.

The introduction to the question group, shown in Figure 33, presented the parking scheme as indicated in section 4.3. Respondents were told to imagine such as scheme in which all parking spaces were subject to, including both private and public spaces. They were then asked to think how they would behave when visiting Leppävaara under the four scenarios presented to them.

During the introduction some colour coding was used to illustrate the difference between the different parking zones. Also time periods were underlined to emphasise their importance in the parking scheme.

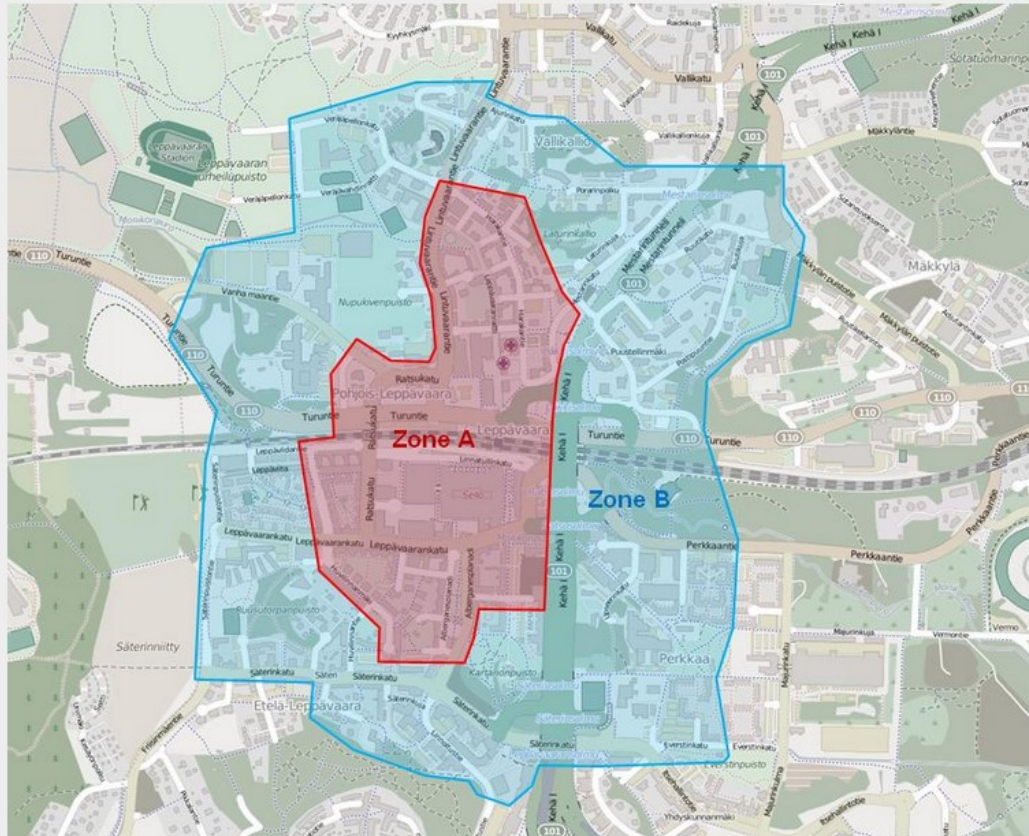
The four questions on this page require you to think about how you would react to a new parking scheme. Please read the information carefully and answer the questions below.

Imagine that **all** parking spaces in the centre of Leppävaara are organised into parking zones.

The cost of parking depends on which zone you park in, and whether you want to park at peak or off peak times.

Peak times are between 0700 - 0900 in the morning and between 1600 - 1800 in the afternoon.

The different parking zones are displayed in the map below. **Zone A**, in the centre is the higher priced zone and **Zone B** has lower pricing. Outside of Zones A and B, there are no parking charges.



Depending on when and where you park, the hourly price of parking is as follows:

1. Parking in **Zone A** at peak time = 4 € / hour
2. Parking in **Zone A** at off peak time = 3 € / hour
3. Parking in **Zone B** at peak time = 3 € / hour
4. Parking in **Zone B** at off peak time = 2 € / hour

? What would you do in these following situations:

Figure 33. Introduction to the scenario questions from the survey

The question itself presented the scenario, clearly stating the purpose (work, shopping, visiting), the zone (zone A or zone B), and the time period (peak, or off peak). The expected hourly cost of parking was also displayed. The multiple choice responses to the

question provided clear alternatives and indicated the impact on parking fee and walking distance that the alternatives would have. They are displayed in Figure 34.

Imagine you are going to Leppävaara to visit a friend for about an hour at 1900 in the evening (off peak time) in **zone A**.

The cost of parking in **zone A** at off peak time is 3 € / hour.

What would you do:

Choose one of the following answers

- ☐ **Make no change to journey:**
Travel by car at off peak time and park in **zone A** (Cost = 3 € / hour)
- ☐ **Park further away:**
Travel by car at off peak time and park in **zone B** and walk for about 10 minutes, to reach your destination (Cost = 2 € / hour)
- ☐ **Park outside of Leppävaara:**
Travel by car at off peak time but park outside of zones A and B, and walk for about 30 minutes, or take a public transport service to reach your destination (no cost)
- ☐ **Would not travel to Leppävaara at all**
- ☐ **Travel by other transport mode** (please state what):
- ☒ **No answer**

Exit and clear survey Resume later ◀ Previous Next ▶

Figure 34. An example of a scenario question from the survey

5.1.7.5 Open question

The final question was an open question with a large empty text field to encourage respondents to write freely. Instructions were provided to give guidance about the sort of things the respondent might like to comment upon. These included the existing parking situation in Leppävaara, parking fees in general, parking zones and time controls, and other comments about the questionnaire. The open question is visible in Figure 35.



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0% 100%

English ▼

PART FIVE: Final comments

Here is opportunity for you to make any comments you might have about parking matters. For example, you might like to tell us what you think about:

- The existing parking situation in Leppävaara
- Parking charges in general
- Parking zones and peak time fees
- Anything else about the questionnaire or the scheme proposed in the questionnaire

Figure 35. The open question from the survey

In addition, there was opportunity for the respondent to leave their email address should they wish to partake in the draw for cinema tickets. See *Figure 36*.

If you would like to enter into the draw for cinema tickets, please enter your email address in the box below:

Exit and clear survey

Resume later

◀ Previous

Submit

Figure 36. Opportunity for respondents to leave email address to enter the prize draw

5.1.8 Exit screen

A final confirmation screen was used, as displayed in Figure 37, to say thank you to the respondent and to confirm that the survey was over. A link on the screen took the respondent back to the welcome page.

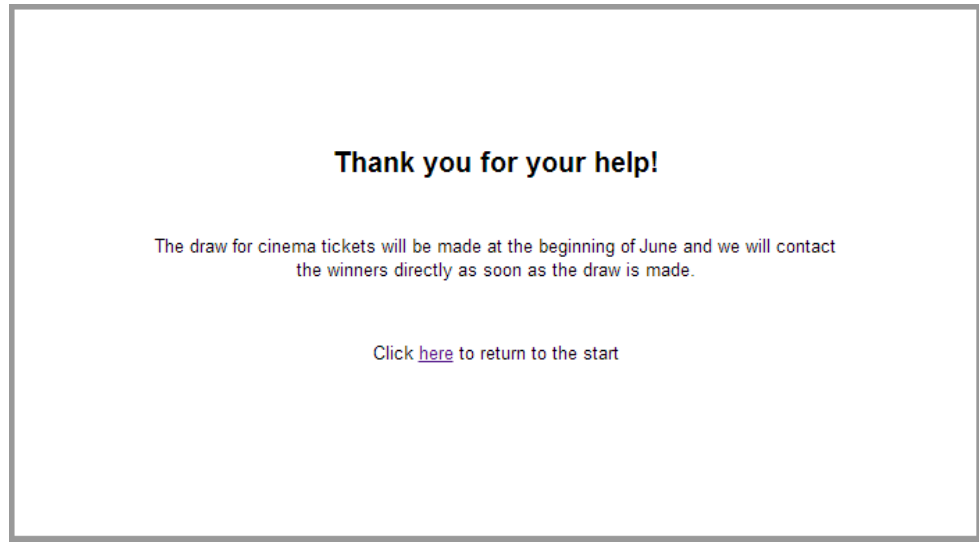


Figure 37. Exit screen from the survey

5.1.9 Stated preference and Revealed preference

The survey uses a combination of revealed preference and stated preference techniques. Revealed choice, where the respondent answers according to their current behaviour can be disadvantageous because it is difficult to cover all variables in a questionnaire. However, the results obtained with revealed choice questions are more reliable[8]. With stated preference, a survey can present a hypothetical situation that covers all variables for the respondent to react to[8]. Of course, being a hypothetical situation, the weakness of stated preference is the question of whether the respondent actually would behave the way they said they would behave[8]. In relation to parking fees for example, a respondent may say that they would never park in a certain area to avoid parking fees. In practice, however maybe they would decide to park in the area on some occasions despite the parking fees. In addition, it is sometimes difficult for a respondent to answer something that they have never experienced[9]. For example, someone might have difficulty if they were to be asked how they would behave if they were to go shopping in a certain area, when they never actually have been shopping in that area.

5.1.10 Consideration of Bias

Within stated preference surveys of this type there is danger of strategic behaviour bias[69].

Strategic bias means that the respondent may answer not according to how they really feel, but according to how they would like to influence policy. For example, a motorist unlikely to want to pay for parking would answer the survey as if they would do anything to avoid parking fees. In reality however, it may be that the motorist would be willing to pay a small fee for parking, but they do not want to give this impression in case it leads to a policy change and parking fees being introduced. To mitigate against this type of bias, effort was made to ensure that the questionnaire was independent of the City of Espoo by using the Aalto University logo and by repeatedly emphasising that the questionnaire is for research purposes only.

5.2 Data collection

The survey was active between 11th May and the 14th June 2015. It was advertised on various relevant Facebook pages, Aalto University Yammer and Inside pages, some message boards and intranet pages, and through direct email.

Direct emails with the link to the survey were sent to employees at City of Espoo Town Planning department and to some students at Aalto University. The link was also advertised on the Aalto University intranet pages. Although the City of Espoo Town Planning department and Aalto University campus are not located in Leppävaara, many employees and students would visit Leppävaara on a regular basis. It was also interesting to obtain responses to part four of the questionnaire, where the different scenario questions were presented, regardless of whether the respondent visited Leppävaara or not.

Direct emails were also sent to the board members of resident organisations at three suburbs of Leppävaara, namely Kilo, Perkkaa and Laajalahti. In addition, emails were sent to some employees at an environmental consultancy within Leppävaara. At all times respondents were encouraged to forward the message on and share the link with friends and family.

The link to the survey was advertised on the following Facebook pages:

- Leppävaara Group NGO (Leppävaara-seura)
www.facebook.com/leppävaaraseura, displayed in Figure 38
- Greater-Leppävaara residents forum (Suur-Leppävaaran Asukasfoorumi)
www.facebook.com/suurleppävaaranasukasfoorumi
- Mission Leppävaara, interactive town planning page (Tehtävä Leppävaara)
www.facebook.com/tehtavaleppävaarassa, displayed in Figure 39
- Linturvaara Group NGO (Lintuvaaralaiset)
www.facebook.com/lintuvaaralaiset
- Pitäjämäki Group NGO (Pitäjänmäki-seura)
www.facebook.com/pitäjänmäkiseurary

In addition, the link was posted on the Leppävaara Group and Leppävaara residents forum web pages.

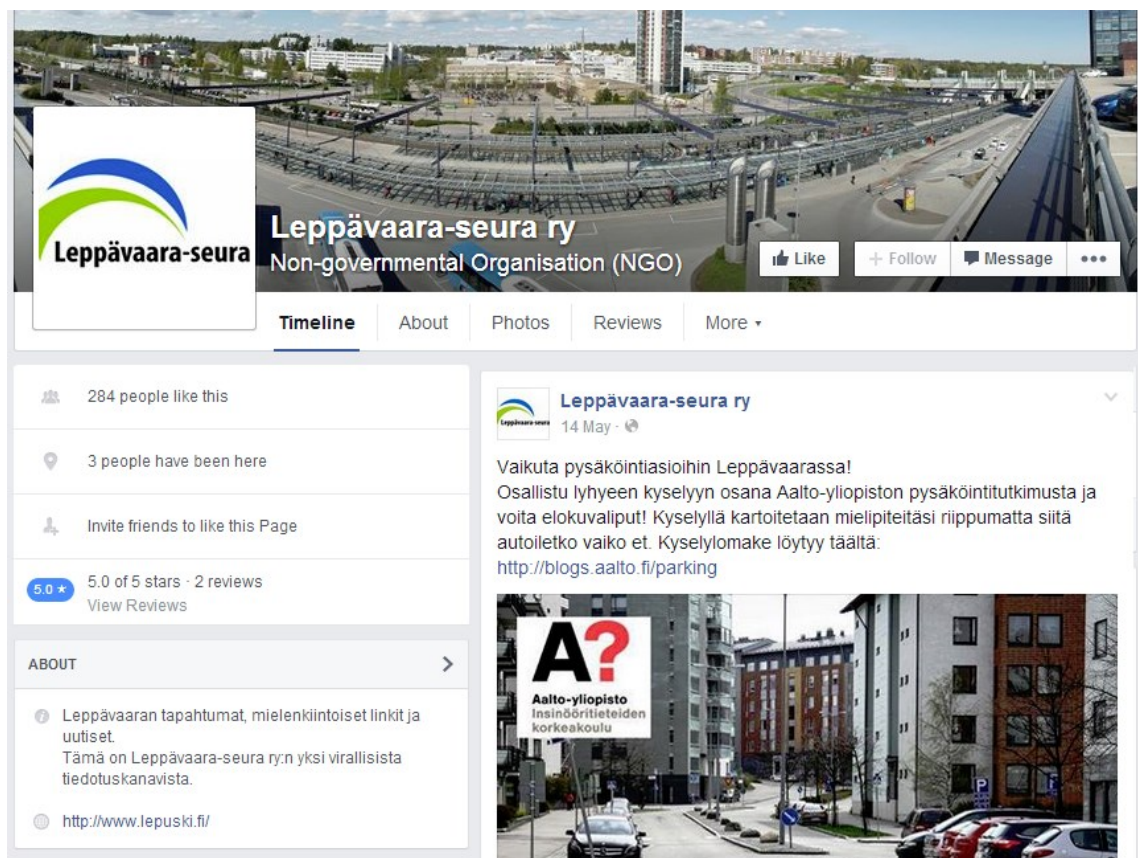


Figure 38. Survey link advertised on Leppävaara Group NGO Facebook page



Figure 39. Survey advertised on the Mission Leppävaara Facebook page

6 Analysis of results

This section investigates the results obtained from the survey and explores relationships within the information obtained. Data obtained is available upon request from the author.

6.1 Survey results

6.1.1 Responses

In total there were 298 responses to the survey, of which 245 were full responses that answered all questions. This left 53 incomplete responses. See Figure 40.

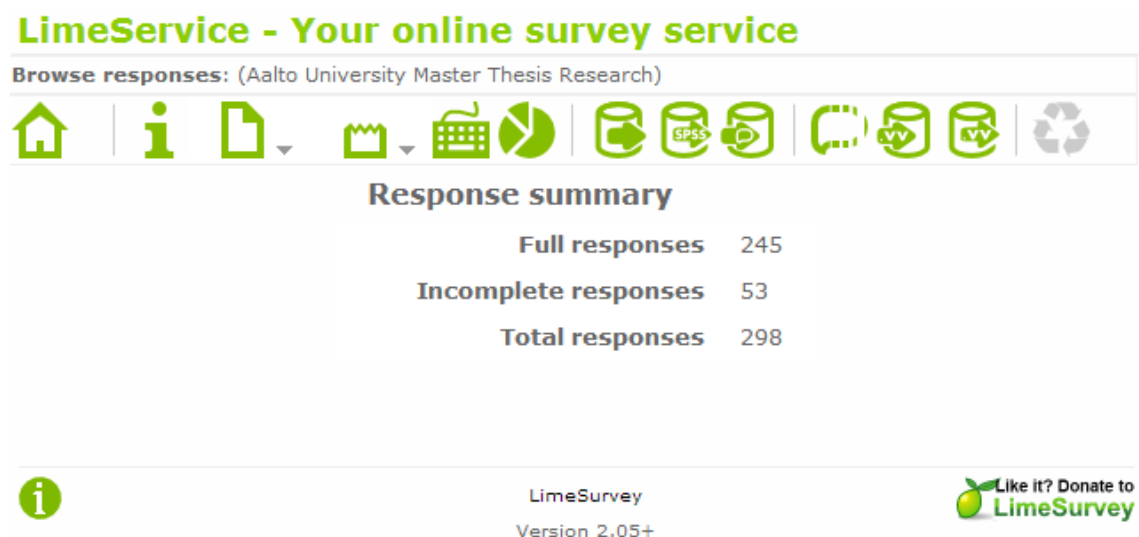


Figure 40. Indication of number of responses received

The number of responses received is satisfactory as more than 200 responses should have a margin of error below 5% for this type of exploratory analysis[70].

Of the 53 incomplete responses 12 did not complete beyond part one, another 12 did not proceed further than part two, three did not proceed beyond part three and 25 did not get past part four. Table 9 shows the points at which people dropped out of the questionnaire.

Table 9. Number of respondents that completed each section

<i>Number of responses</i>	<i>Part</i>
12	Part one: Demographics
12	Part two: Relationship to Leppävaara
3	Part three: Travelling behaviour
25	Part four: Scenarios
2	Part five: Open comments
245	Submitted response
Total: 298	

The fourth part of the questionnaire was a set of four demanding stated preference questions, asking respondents to imagine a hypothetical situation and then consider how they would react in that situation. Because of the demands of the question, the fairly high proportion of respondents who did not complete this stage was expected. The two respondents who did not complete beyond part five had in practice answered all questions on the survey but failed to click the “submit” button.

For the purpose of this research 27 respondents who did not complete beyond part three of the questionnaire were discounted. Furthermore, three full responses were deleted because they were test responses conducted by the researcher. In total this left 242 full responses which could be used to analyse all parts of the questionnaire, and 266 responses which could be used to analyse parts one to three.

6.1.2 Demographics

The demographic background of the 266 respondents can be seen in the graphs in Figure 41.

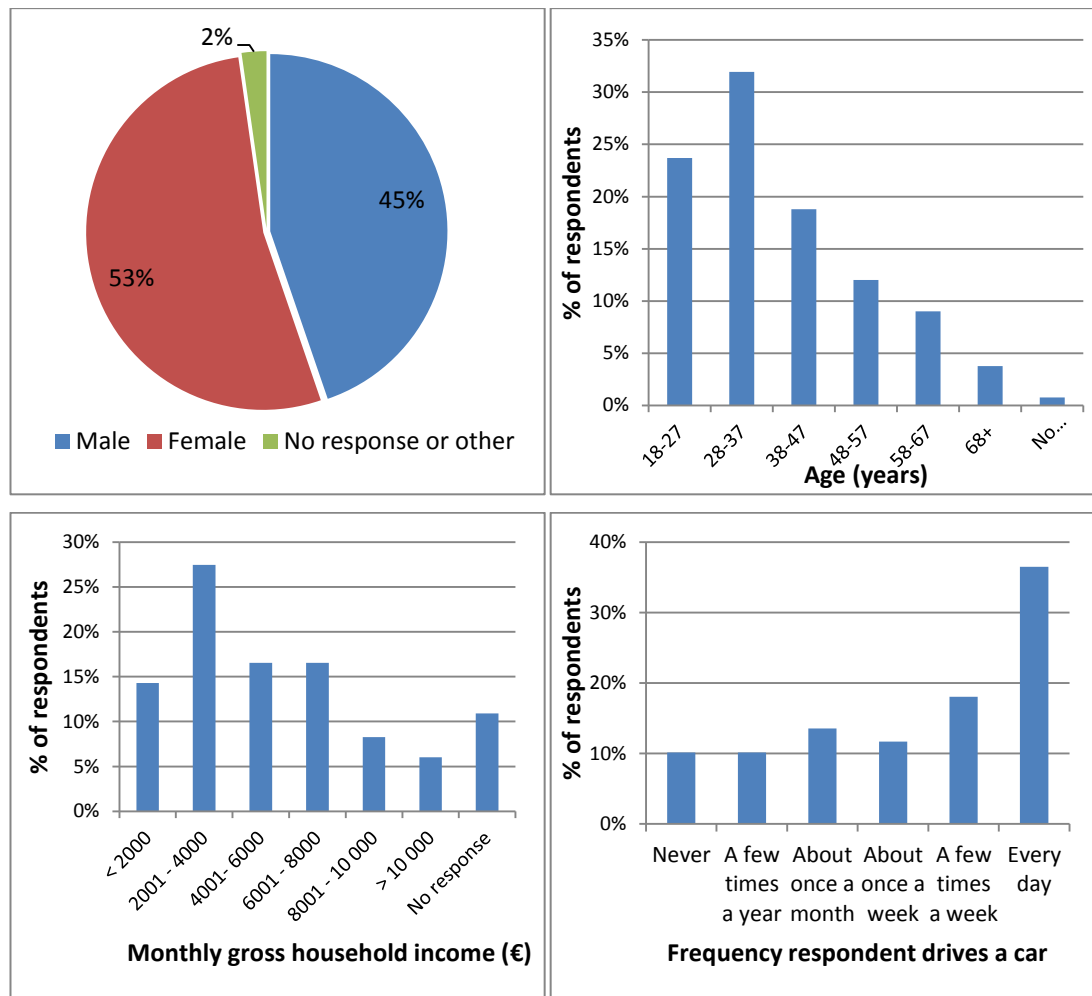


Figure 41. Summary of demographic results

The gender split was fairly even, with a slightly greater proportion of female respondents. Most respondents were between 18-37 years of age, with slightly under 50 percent between the 38 – 65+ categories. This is therefore a fairly young sample, which can perhaps be attributed to the online distribution method of the survey. Income is fairly well distributed although a majority have a monthly gross household income of between 2,001 to 4,000€. A significant number however, over 10%, chose not answer the question relating to monthly earnings. With regard to frequency of driving a car, only 10% of respondents said that they never drove a car and another 10% said they only drove a few times a year. Over 60% said that they drive once a week or more.

The geographical distribution of respondents according to postcode district can be seen in Figure 42.

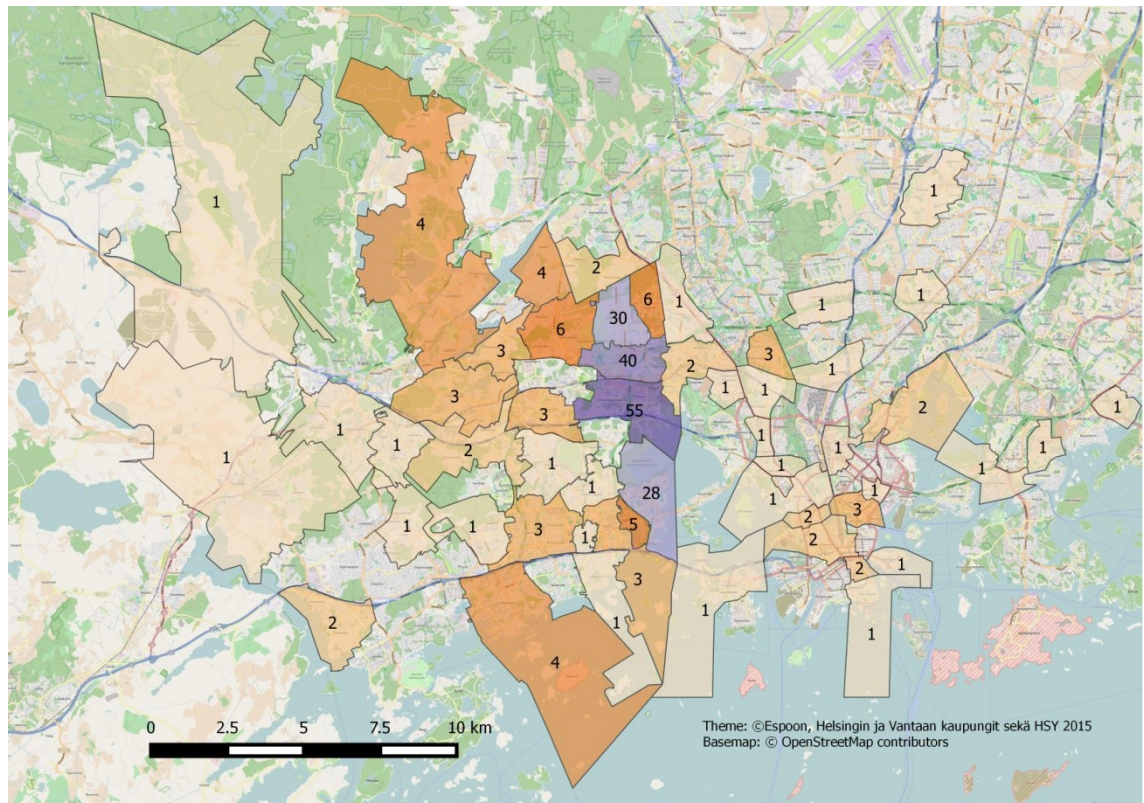


Figure 42. Number of responses from postcode areas across the HMA

The vast majority of respondents came from the Leppävaara area, with 70 responses coming from two postcode areas in Leppävaara that are situated north of the railway line, and 55 responses coming from the postcode area in Leppävaara that is situated south of the railway line. There were 28 responses received from Otaniemi, where the student campus is located. This indicates a high response rate amongst students. The rest of the responses are distributed fairly evenly across the HMA. Not shown on the map are approximately six additional responses received from outside the HMA, including the districts of Kirkkojärvi, Sipoo, Kerava, Nummijärvi, and Nummela.

6.1.3 Relationship to Leppävaara

The frequency that respondents visit Leppävaara for shopping, work, and social purposes can be seen in Figure 43.

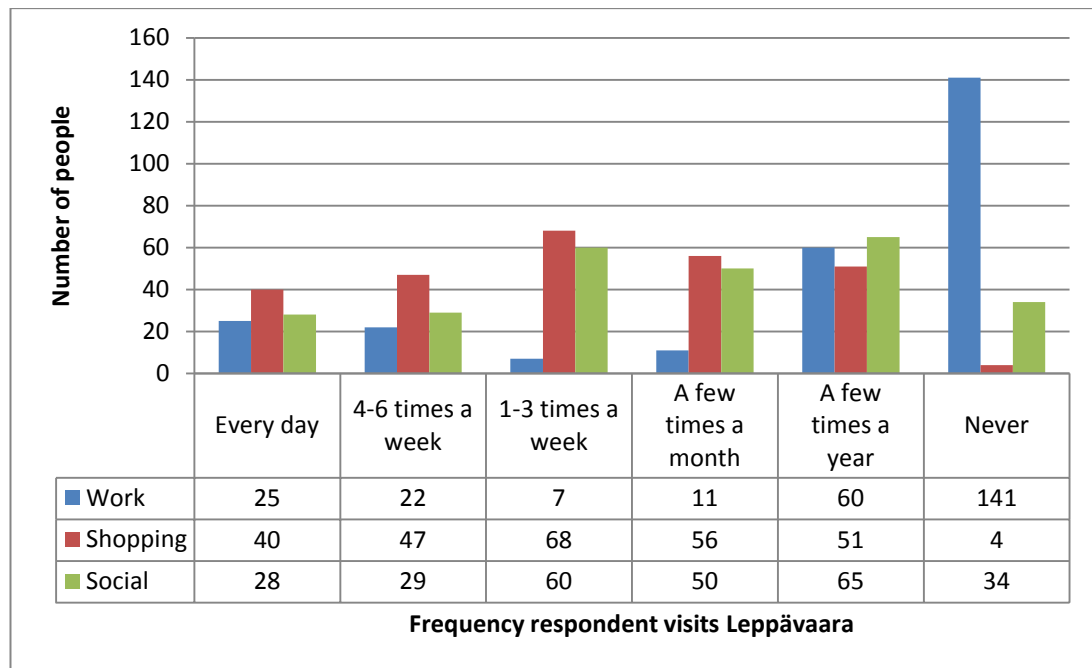


Figure 43. Frequency person visits Leppävaara for different purposes

A significant number of respondents, over 140 or about 52% said they never visited Leppävaara for work purposes. Exactly 60 people, representing about 22% of all respondents said they only visit Leppävaara for work purposes on a few occasions a year. Just under 20% of respondents said they work in Leppävaara either every day, or 4-6 times a week.

The number of times someone visits Leppävaara to go shopping or for social purposes is distributed more evenly. However only four respondents said that they never visit Leppävaara to go shopping which perhaps highlights the popularity of the Sello shopping mall in the centre of Leppävaara.

The typical duration of a visit for different purposes is displayed in Figure 44.

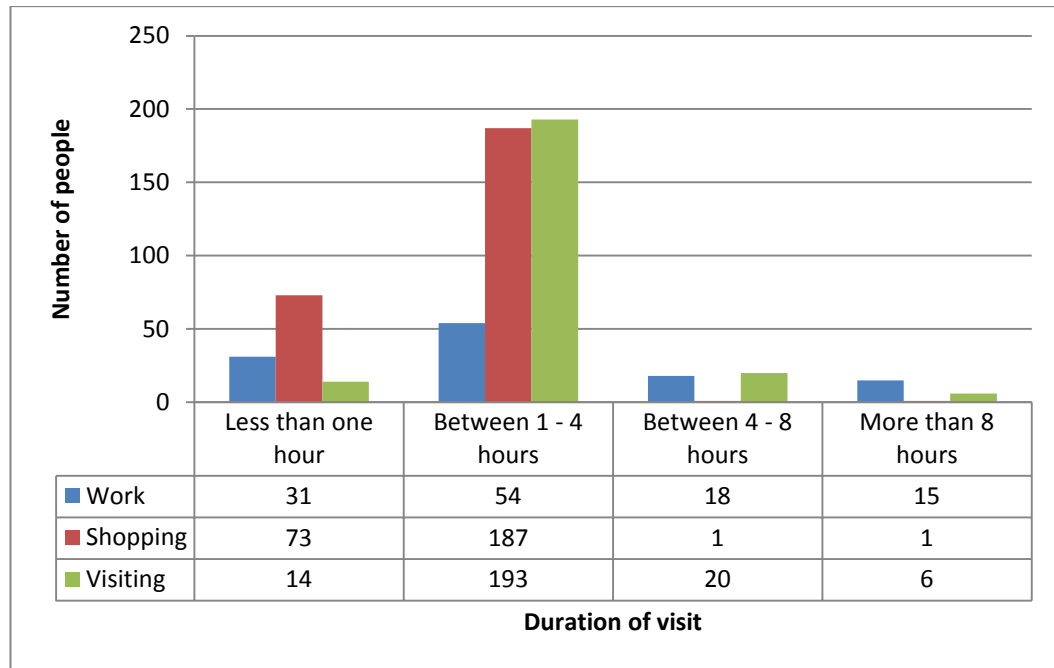


Figure 44. Duration of visit when person visits Leppävaara for different purposes

The different time categories for this question are not even because the questionnaire was designed to differentiate between short term parking and medium term parking. It is therefore not too surprising that for shopping and visiting purposes more people stay between 1 and 4 hours than for less than one hour because the 1 to 4 hour time category is three times longer than the first category, less than one hour. Nonetheless, it can be seen from the results that people who park for less than one hour are usually shoppers and a shopping visit rarely lasts more than 4 hours. The vast majority of visits for social purposes last between 1 – 4 hours. The time someone spends in Leppävaara when visiting for work is distributed more evenly.

Different modes of travel people use when they visit Leppävaara are displayed in Figure 45.

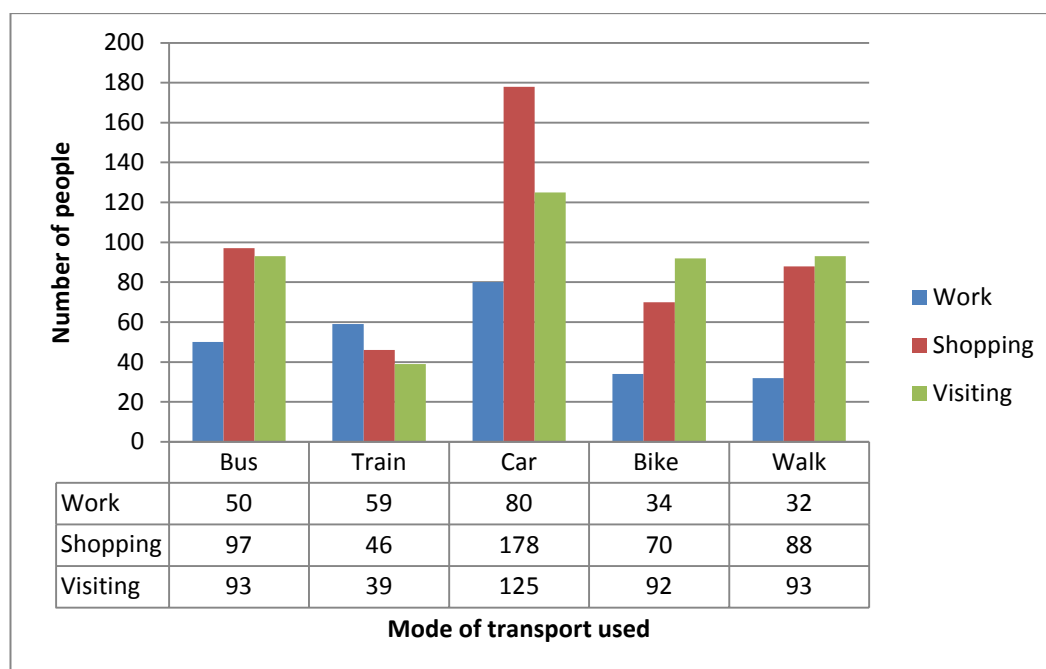


Figure 45. Mode of transport used when visiting Leppävaara for different purposes

Respondents were able to select more than one answer to this question, to reflect the fact that many journeys are multimodal. Nevertheless, for shopping, work, and social purposes, the car is the most popular mode of travel. In particular the car is a popular travel mode for shopping, being used almost twice as much as the next most popular mode of travel. This might be because shopping often entails carrying bags which is more difficult on public transport. Out of the public transport modes, the bus is more popular than the train. This is probably because the coverage of the bus network is far greater than the coverage of the train network.

6.1.4 Parking behaviour

The question regarding where a person normally parks was not asked to respondents who answered that they never drove a car. Of the remaining respondents, most said that they parked off street, as displayed in Figure 46. The vast majority of shoppers parked off street which perhaps illustrates the popularity of the shopping mall's underground car park which has 2,900 parking spaces[71]. On street parking was more typical for those visiting Leppävaara for work or social purposes.

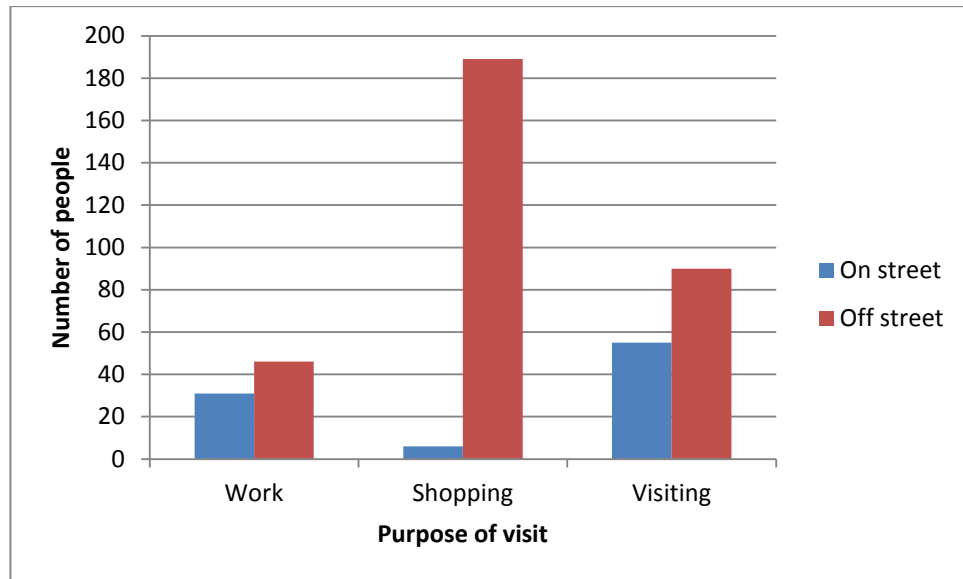


Figure 46. Usual type of parking space used when visiting for different purposes in Leppävaara

When asked where they would prefer to park, as indicated in Figure 47 most respondents answered that they would prefer to park off street, and about a third answered that they would prefer to park on street. Interestingly, when a similar survey was conducted in Helsinki the results were reversed, and 66% of respondents answered that they would prefer to park on street.

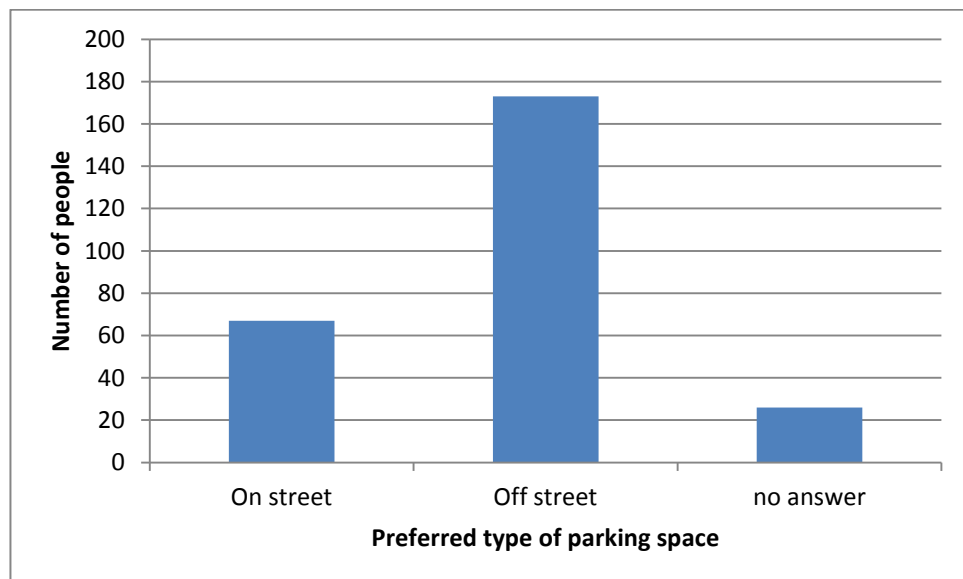


Figure 47. Preferred type of parking space

As can be seen in Figure 48, the preferred payment method was the mobile phone, with credit or debit card the second most popular payment choice.

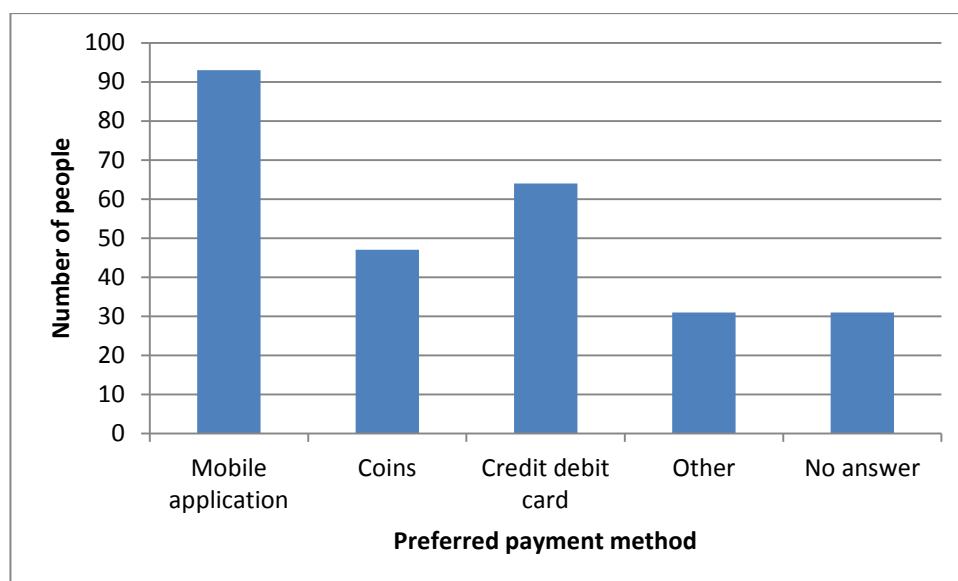


Figure 48. Preferred payment method when paying for a parking space

There were 31 people, representing more than 10% of all respondents that chose “other” payment mode. This was made up of 17 out of 31 using the “other” field to say that their preferred mode was free parking or payment through taxation, three out of 31 saying that there should be a monthly cost, for example as part of the housing maintenance fee, five out of 31 said using a bank card (although this was an option in the questionnaire), and two said through a SMS text message or phone, which probably represents those who do not have a smart phone or prefer to use SMS instead of mobile phone applications. Out of the remaining three respondents, two said that there should be time or disability restrictions, and one said that they would prefer to pay with the public transport travel card. Similar results were obtained from similar questions conducted in a survey in Helsinki where phone applications and credit cards were popular preferred methods of payment.

Over 50% of respondents answered that a reasonable hourly cost of parking should be between 0 – 1€. This was the lowest possible category as it was decided not to include an option for free parking. The full results of this question can be seen in Figure 49.

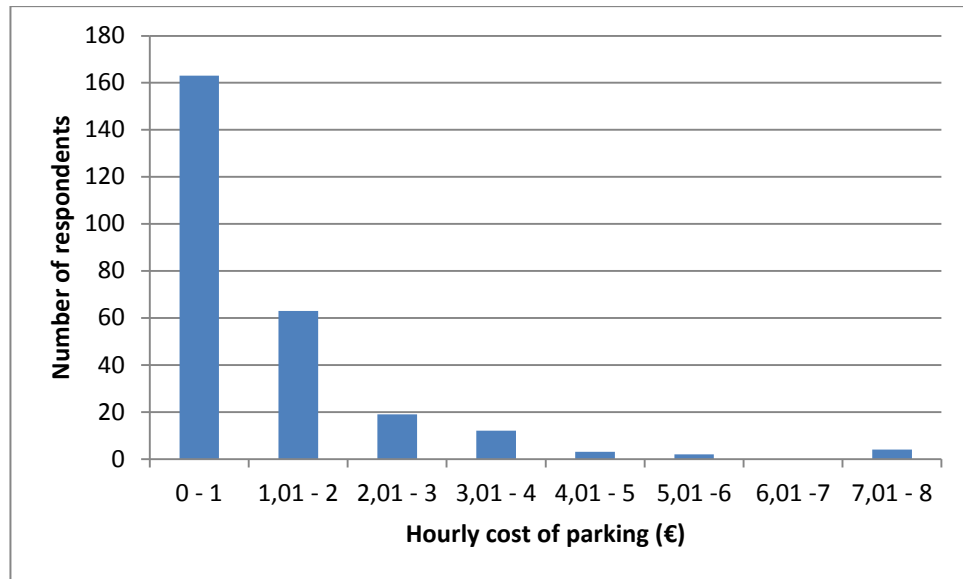


Figure 49. What respondents think is a reasonable hourly cost of parking

At the other end of the scale, a very small proportion chose the highest category, which was 7,01 – 8€/hour whilst nobody chose 6,01 – 7€/hour.

6.1.5 Parking scenarios

As explained in section 5.1.7.4, there were twelve different parking scenario questions of which a random set of four were presented to the respondent. This meant that each question was not asked to all 242 respondents who answered part four of the questionnaire. On average, the response rates for the parking scenario questions were around 70 responses per question.

The effects of the dynamic parking scheme upon shoppers is summarised in the graphs in Figure 50.

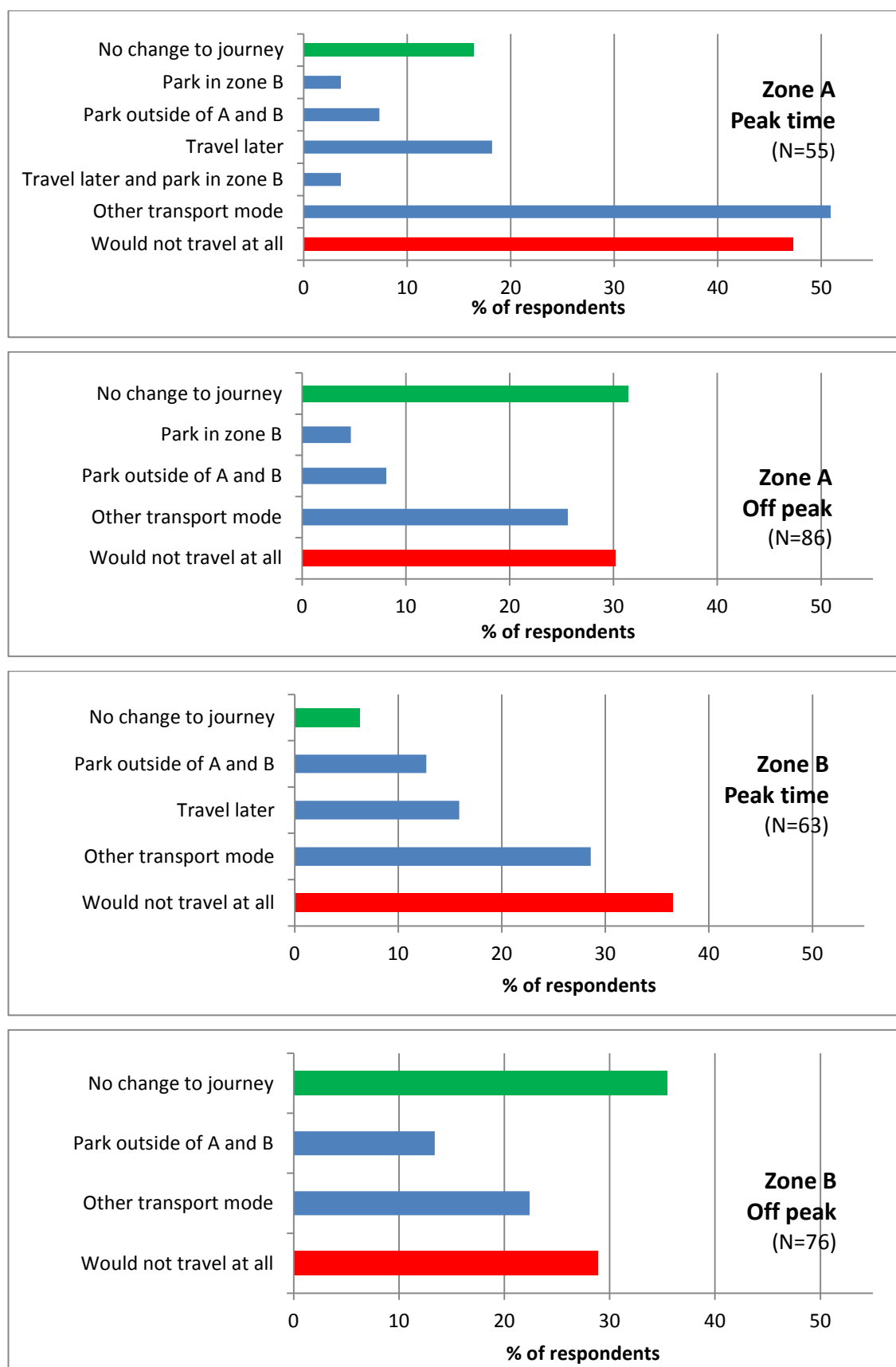


Figure 50. Changes in behaviour when visiting Leppävaara for shopping purposes for one hour under the dynamic parking scheme

For shopping purposes, a higher proportion of respondents would make no change to their journey when shopping at off peak times. During peak time only 5% of shoppers in zone B and 15 % of shoppers in zone A said that they would make no change to their journey. However this rises to over 30% in both zone A and zone B during off peak time.

When changing behaviour to avoid the highest parking fee, changing to another transport mode is always the most popular alternative. Usually the bus or train is preferred although some respondents said that they would walk or take a bike to the shops. It is also evident that for shoppers, travelling later is preferable to parking further away. An explanation for this may be the reluctance to walk with heavy bags of shopping over a long distances.

A significant proportion, over 45%, said they would not travel at all to Leppävaara to go shopping in zone A at peak time. Over 25% also said they would not travel to Leppävaara to go shopping in zone B at off peak time. This high percentage may be explained by the presence of other nearby shopping malls which drivers can easily access to avoid paying for parking.

For work purposes in Leppävaara, changes to behaviour under the dynamic pricing scheme are displayed in Figure 51.

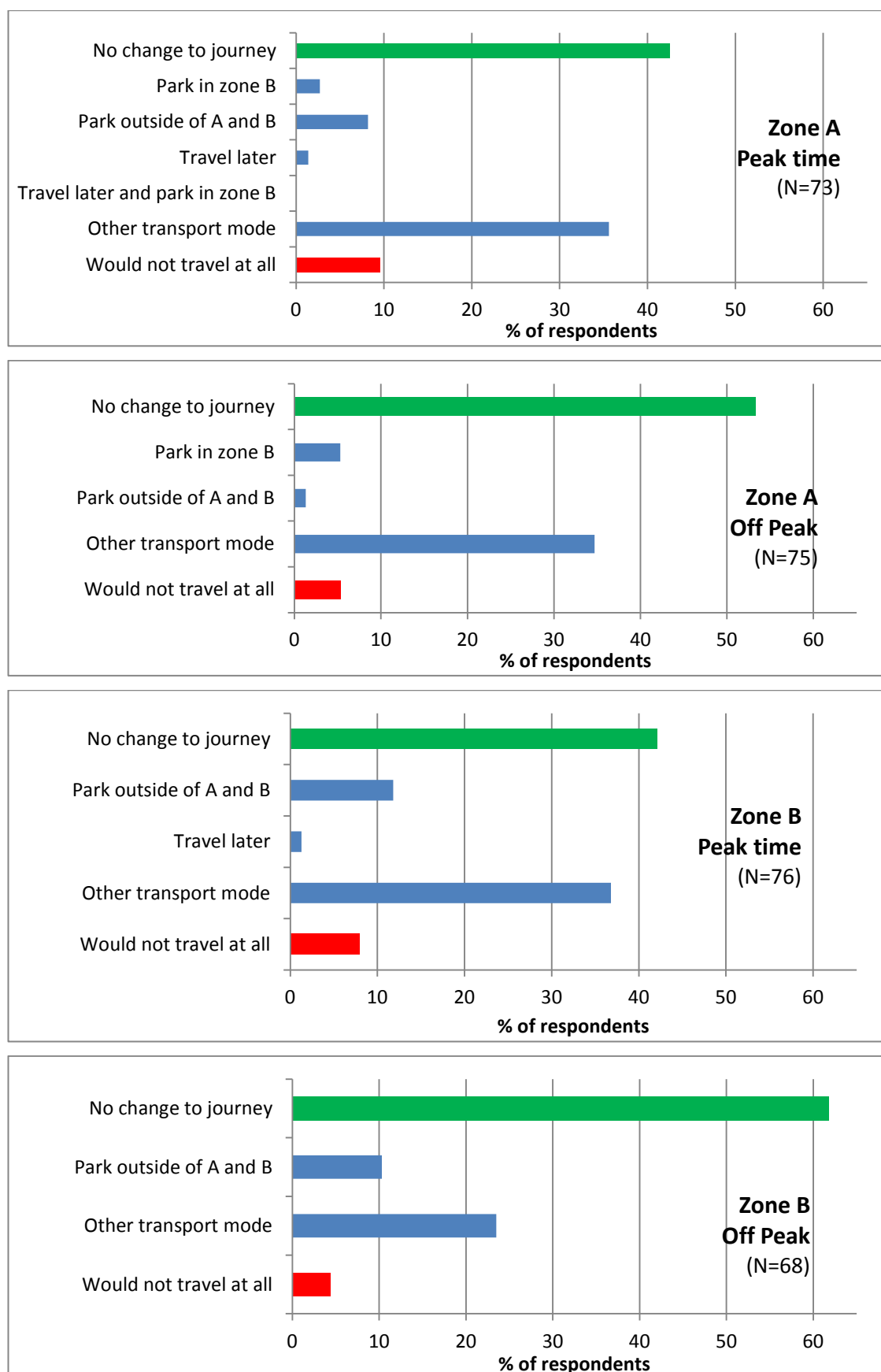


Figure 51. Changes in behaviour when visiting Leppävaara for work purposes for one hour under the dynamic parking scheme

Compared to shoppers, there is much more tolerance of paying for parking for work purposes. In all work based scenarios at least 40% of respondents said that they would not change their journey, and less than 10% said they would not travel at all. This is perhaps because many employers cover the cost of parking and so parking fees are not such a deterrent to individual motorists travelling for work purposes.

Those who change their behaviour usually opt for another transport mode. For the City of Espoo, this is potentially a positive change to more sustainable transport modes which should be encouraged. There were slightly more respondents who said that their preferred alternative transport mode would be the train, some also answered that they would travel by taxi which for which the employer would likely pay the cost. Again, it is likely that the employer would cover the cost of a public transport ticket. Unlike shopping, people travelling for work would prefer to park further away from their destination than travel later to avoid the higher parking fees. This may be because it is more difficult to reschedule work meetings.

For visitors and social purposes, the graphs showing changes to behaviour under the dynamic parking scheme are displayed in figure 52

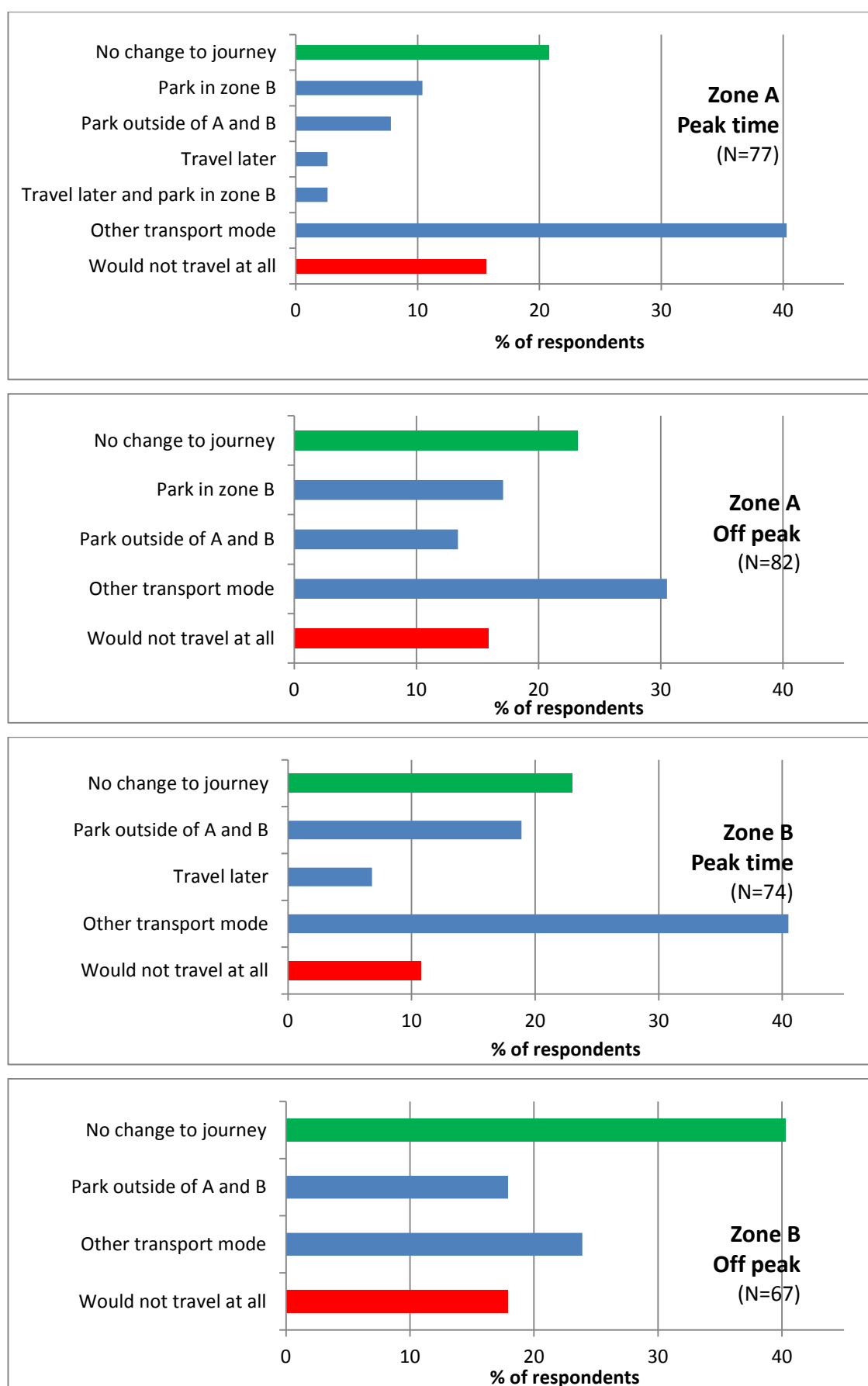


Figure 52. Changes in behaviour when visiting Leppävaara for social purposes for one hour under the dynamic parking scheme

There is little change between the proportions of respondents who say they would not travel at all for social purposes in a dynamic parking scheme. In general, regardless of time or location, between 10 to 15% of respondents said they would not visit Leppävaara if they had to pay for parking.

As an alternative to paying for parking fees, most respondents said they would take another transport mode either public transport, or walking or cycling. This is particularly evident during peak times when for those parking in both zone A and zone B, over 40% of respondents said they would use another transport mode instead of paying for parking. Social activities and visiting friends often does not require carrying bags, which could mean that travelling by public transport or going by bike seems more manageable.

People travelling to visit friends usually choose to park further away instead of travelling later to avoid the fees.

6.1.6 Open comments

There were 144 open comments left as part of the survey and can be broadly broken down into three categories, comments regarding the questionnaire and the proposed dynamic parking scheme, comments regarding the existing situation in Leppävaara, and comments regarding their attitudes to fees and how they feel that fees will impact upon development.

Most comments were written in Finnish and later translated into English for analysis.

A list of common comments regarding different aspects of the questionnaire and the dynamic parking scheme are broken down and displayed in Figure 53.

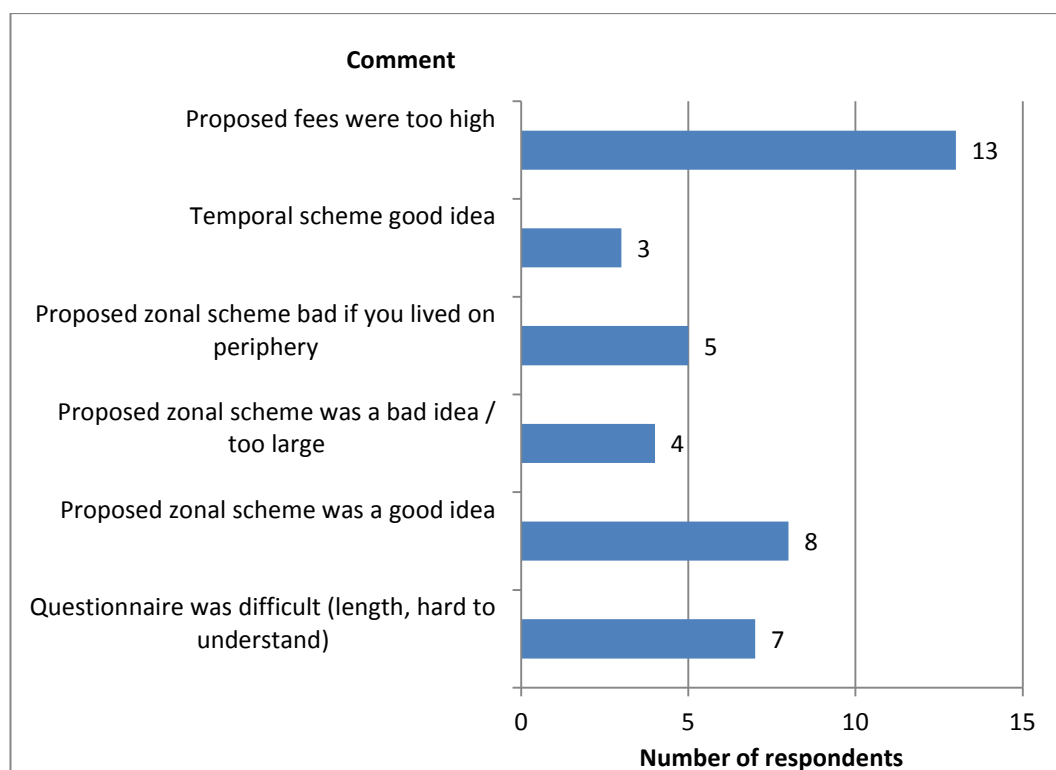


Figure 53. Number of open comments received regarding the proposed parking scheme and the questionnaire

There were 13 comments (5% of all respondents) saying that the fees in the dynamic parking scheme were too expensive, and altogether nine comments (4% of all respondents) saying that the zonal scheme was a bad idea with five of these expressing concern about those who live on periphery of the zones where parking problems may increase if parking fees are introduced nearby. There were eight comments (3% of all respondents) saying that the zonal scheme was a good idea and three (1% of all respondents) praising the temporal scheme. Seven people (3% of all respondents) commented that the questionnaire was difficult to understand or was too long. This is a small and therefore acceptable number of respondents complaining about questionnaire difficulty which does not influence validity of the questionnaire.

Comments regarding the aspects of the existing parking or transport situation in Leppävaara are displayed in Figure 54.

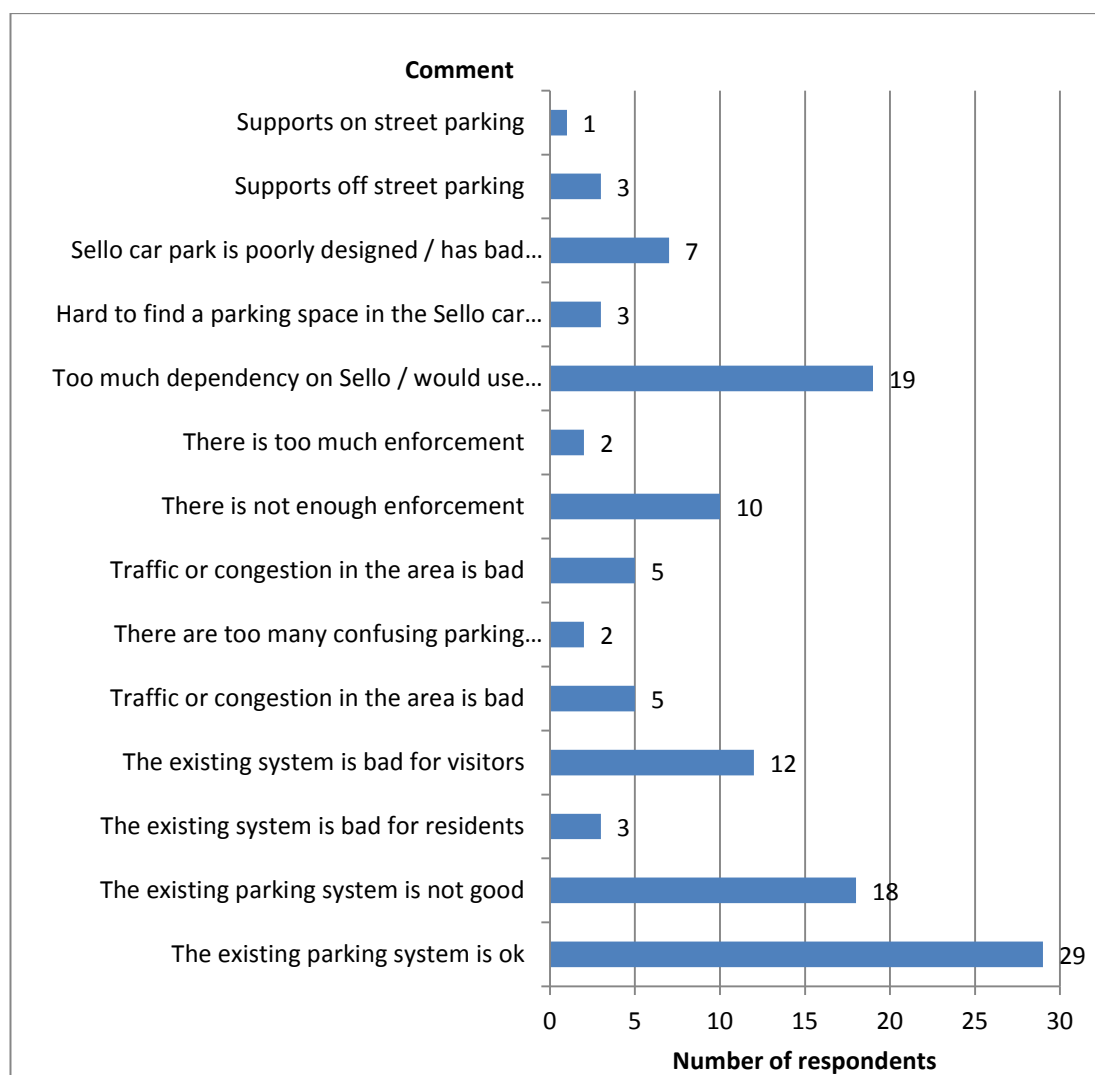


Figure 54. Number of open comments received about the current parking situation in Leppävaara

Many people, a total of 29 (12% of all respondents) commented that the existing parking system in Leppävaara is ok. This compared to about 18 (7% of all respondents) who said that the existing parking system is not good. Some people elaborated on this with 12 people (5% of all respondents) saying parking is not good for visitors in particular. A lot of the people who said that the parking system in Leppävaara is ok, went on to use this as a justification against fees which could suggest an element of strategic bias. One interesting problem that the open comments brought up was the issue of enforcement. There were 10 comments (4% of all respondents) saying that there is not enough enforcement of parking, which means that people park illegally in disabled bays or they park much longer than the time limit permitted. On the other hand, two people (1% of all respondents) suggested there is too much enforcement. In addition, the influence of Sello could not be ignored. 19 people (8% of all respondents) say that they would use

free parking facilities at Sello or that there is in Leppävaara there is too much dependency on Sello. There was also criticism that the Sello shopping centre is poorly laid out and it is sometimes difficult to find a parking space.

Open comments regarding fees are displayed in Figure 55.

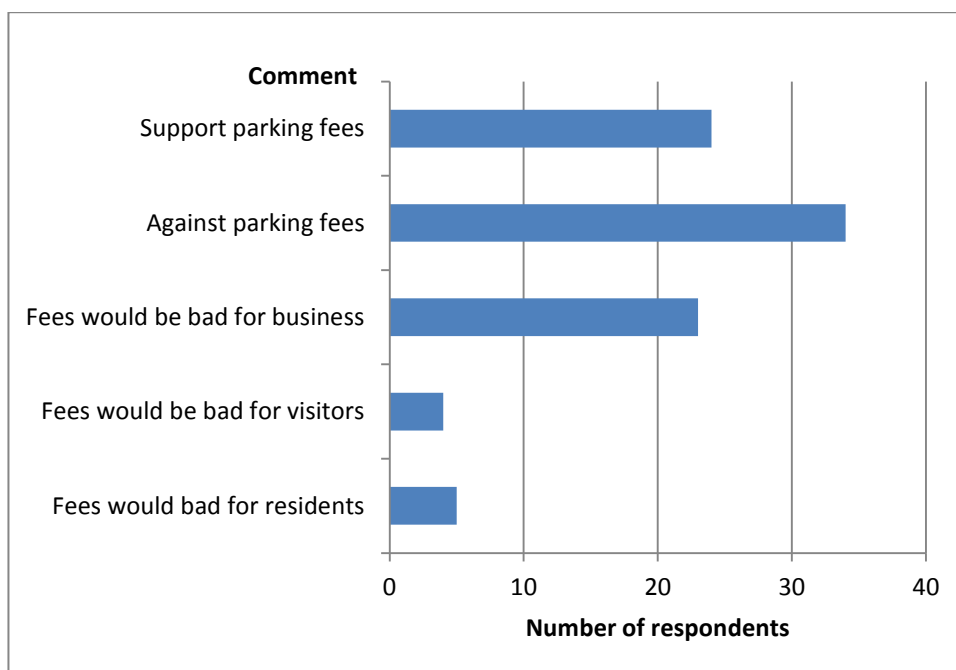


Figure 55. Number of comments received regarding the idea of parking fees in Leppävaara

As the questionnaire results indicated, most people, 34 (14% of all respondents) were against the principle of parking fees of which seven were strongly against, with some saying for example:

- *“NO to parking fees! Free parking spaces are the reason why people come to Leppävaara and spend money and use services”*
- *“Parking should be free all day long! Leppävaara is not London!”*
- *“Why should Leppävaara be forced into being as an idiotically and expensive place to use (and shop) by car as in Helsinki? Is there congestion in Leppävaara - no. Is there pollution in Leppävaara - no. Is private parking in Leppävaara as messed up as in Helsinki - no.”*

This contrasts with 24 people (10% of all respondents) who used the comments to say that they would support fees. Most people supported on basis of equality, in that it is unfair to pay for parking if you do not own a car.

A lot of people used comments to say that fees would be bad for business. This is often feared but as previous research has shown, this is not always the case because less traffic can make a place more pleasant and more accessible.

Finally, the comments section raised a number of interesting points which are worth briefly highlighting here. They were:

- Parking policy should be agreed regionally to avoid competition between regions and shopping malls.
- A fast turnover of parking spaces is needed to serve more people.
- Fees should be based on demand, so they should be much more expensive in areas of high demand and much cheaper where there is less demand.
- Theoretically some said they support fees but they admitted that in practice they would drive elsewhere if they could get free parking.
- It was noted that often the employer covers transport costs, so parking fees do not affect workers to a significant extent.
- There should be discounts for low emission vehicles.
- Robotic parking solutions should be considered.
- Parking could be operated as a service with monthly charge allowing the motorist to park on street.
- Progressive pricing should be considered, where fees rise with each consecutive hour parked.
- The price differences in the proposed dynamic parking scheme should be larger to encourage changes to behaviour.
- The zonal scheme adversely affects elderly, or those who have difficulty walking.
- Improved information is needed at parking facilities.
- Comments regarding the Leppävaara parking company and its perceived lack of transparency in decision making.

7 Detailed analysis and discussion

In this section the survey findings are analysed in greater detail, including a summary of main lessons learnt from the results and comparison of different variables.

7.1 *Initial findings from the survey*

The survey represented a good share of the demographic, with proportions of age, income, and gender being fairly balanced. Most respondents visited Leppävaara regularly to go shopping, and many visited for social reasons on a regular basis. People who responded to the survey visited Leppävaara for work purposes less regularly.

There seemed to be strong opposition to parking fees, which may have been exaggerated by the presence of strategic bias. Nonetheless there was a large proportion of respondents who believed that a small fee of between 1€ – 3€ / hour was reasonable. Further investigation into the results of this question can be found in section 7.2.1.

Most respondents said that they normally do not park on street, especially when visiting Leppävaara for shopping purposes. This perhaps indicates the importance of the large car park at the Sello shopping mall. A larger proportion of those visiting for social reasons and for work purposes park on street. This agrees with findings from the parking analysis of Leppävaara in section 4.2 where it was suggested that most on street parkers should be people visiting friends or some short term workers. Of course, this questionnaire did not take long term parking into account, which includes residential parking. The open comments section revealed that a lot of people parking on street after the enforcement period ends are residents.

In terms of where respondents would prefer to park, the majority said they prefer off street parking. This contrasts with research undertaken in the centre of Helsinki, where respondents preferred to park on street. This may be because in Helsinki the centralised car parks are located further away from the final destination, whereas in Leppävaara the final destination is more accessible from the off street car parks. In both Helsinki and Leppävaara there is a majority of respondents who prefer to pay for parking using a mobile phone application.

The dynamic parking scheme allows respondents to choose between parking further away and travelling later to avoid high parking fees. For shoppers, most chose to travel later which is probably because parking further away is impractical when they have to carry bags of shopping back to their car. For workers and visitors however, most would park further away. If it is assumed that parking fees would only in practice be implemented at the on street level, and that the majority of shoppers park off street, then this would mean that people parking on street (social visitors and workers) would more likely park further away to avoid parking fees than park later.

In all instances however, the majority of people say that they would prefer to travel with another transport mode to avoid the parking fees proposed in the dynamic parking scheme.

A lot of people who visit Leppävaara for shopping purposes said they would not travel to Leppävaara if they had to pay for parking. This is probably because there are other large shopping centres nearby with good accessibility by car[72]. If they can provide free parking, then it is not a significant obstacle for motorists to drive to another shopping centre.

A much smaller percentage of people visiting Leppävaara for work purposes said they would not travel to Leppävaara if they had to pay for parking. The employer usually pays for parking and so parking fees are not such a deterrent for the individual.

For social visitors, there was more tolerance to parking fees with only 10-15% of respondents saying they would not travel to Leppävaara if parking fees were implemented. Visitors have more flexibility than workers and shoppers. They can arrange meetings with friends at later times, at different locations, or can travel by bus without having to carry large bags of equipment of shopping.

Further analysis of the scenario questions can be found in section 7.2

The open questions revealed a range of concerns regarding the parking situation in Leppävaara. However, the majority of respondents said that the existing situation is satisfactory. This is consistent with research undertaken in the Espoo Transport Barometer

in 2012 where only 20% of respondents in Leppävaara said the parking situation is not satisfactory[54]. Of concerns that were raised, the perceived lack of enforcement was interesting. On street parking spaces are currently restricted by time limits, but if these limits are not enforced then people can park for as long as they desire. Furthermore, time limits are only enforced until the early evening, meaning that people can park in the spaces for long periods of time starting from the afternoon. The comments showed evidence that residents use on street parking spaces, despite the fact that parking analysis indicated that there should be enough parking spaces available for residents in their off street parking facilities. When residents use on street parking spaces, this makes things more difficult for social and other short term visitors. The importance of the Sello shopping centre and the potential of shared parking were also brought forward in the comments. The number of parking spaces changes throughout the day, and in the evening when businesses and the shopping centre is closed, there are many unused parking spaces which could be used by other short term visitors for example.

7.2 Further analysis of survey

This section explores possible relationships involving the location of the respondent and the frequency the respondent visits Leppävaara.

7.2.1 Reasonable cost of parking

The results of the survey indicated strong opposition to parking fees with most respondents indicating that a reasonable cost of parking should be between 0 - 1€ / hour, which was the lowest category available for them to choose. This is perhaps because of the high number of regular drivers who answered the questionnaire. In addition, it has been stated that monthly income impacts upon willingness to pay for parking. The demographics data collected as part of the survey provides opportunity to investigate these relations further.

Figure 56 shows what respondents consider is a reasonable hourly cost of parking for respondents with different levels of monthly income. A relationship is clearly present, with higher earners selecting higher values for a reasonable hourly cost of parking.

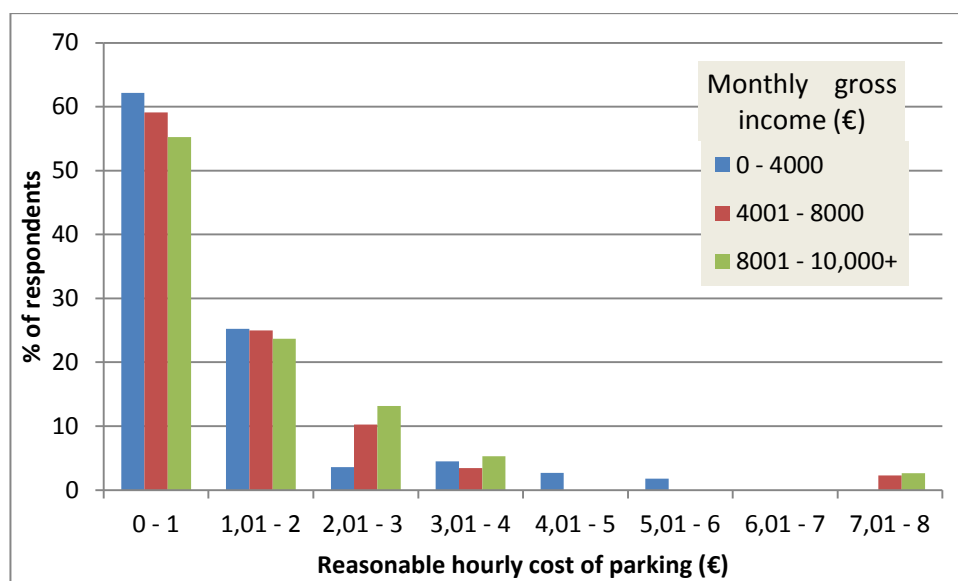


Figure 56. What respondents think is a reasonable hourly cost of parking grouped by monthly income

In Leppävaara however, the relationship between what respondents considered a reasonable hourly cost of parking and how often the respondent drove a car, was even stronger than the relationship between reasonable hourly cost of parking and income. The results can be seen in Figure 57.

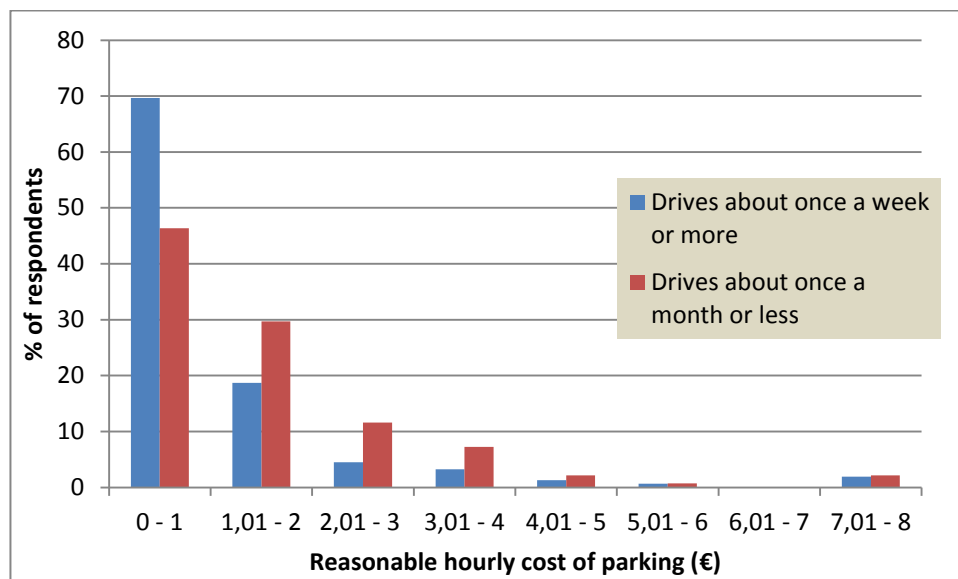


Figure 57. What respondents think is a reasonable hourly cost of parking grouped by frequency they drive

People who drive about once a month or less are more likely to consider that a fee of between 1 to 3€/hour is reasonable. Interestingly, about a quarter of regular drivers also agreed that parking fees between 1 to 3€/hour is a reasonable cost.

7.2.2 Further analysis of scenario questions

This section examines further the results obtained from the scenario questions, in which a scenario was presented to the respondent and the respondent would think how they would react in the scenario. Each scenario provided a purpose why the respondent would be travelling to Leppävaara (shopping, work, or social reasons), along with a location and a time period in the dynamic parking scheme. The appropriate hourly fee for parking was also indicated. Generally speaking, the respondent had three choices. These were:

- make no change to the journey
- not travel to Leppävaara at all
- travel to Leppävaara, but change behaviour in a choice of ways to avoid paying the highest parking fee.

Figure 58 explores the results first two options.

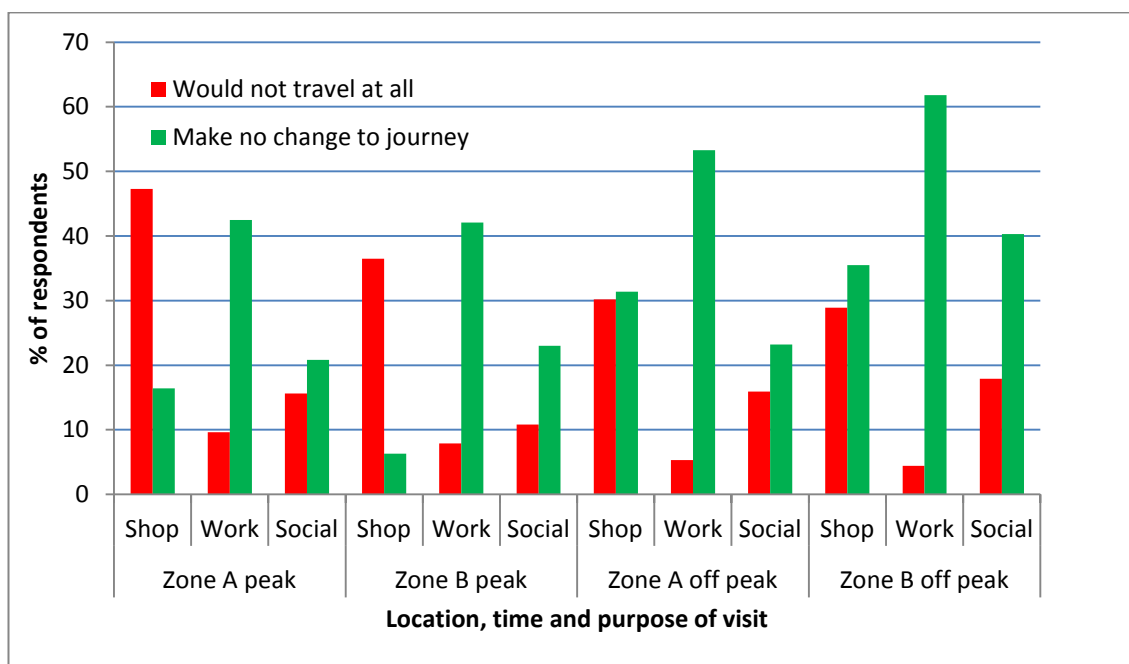


Figure 58. Comparison of those who say they would not travel at all and those who say they would make no change to journey under different scenarios of the dynamic parking scheme.

In all cases tolerance of the parking fees, indicated by the percentage of respondents who say they would make no change to journey increases as the dynamic parking fee drops.

The proportion of respondents who say they would not travel to Leppävaara at all only rises above 20% for shoppers. In the worst instance, where fees would cost 4€/hour there is significant opposition, with nearly half of shoppers saying they would not travel at all. Amongst those visiting for social reasons, at most around 15% say that they would not visit Leppävaara at all.

When changing behaviour to avoid parking fees, the respondent had between two and five options to choose from, depending on the scenario presented. The options were:

- Change to another transport mode
- Travel later and park in zone B (if parking in zone A at peak time)
- Travel later (if parking in zone A or zone B at peak time)
- Park outside of zone A and B
- Park in zone B (if parking in zone A at peak or off peak time)

The graph in Figure 59 presents the results of how people would change behaviour under different scenarios.

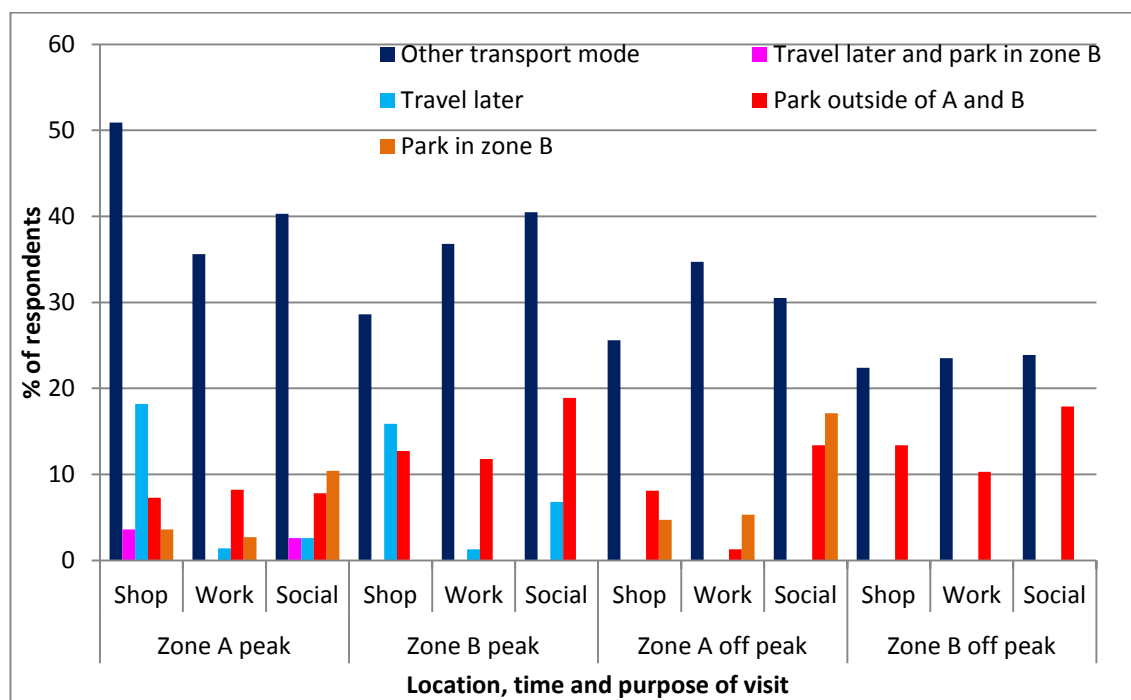


Figure 59. Comparison of how respondents would change behaviour under different scenarios of the dynamic parking scheme

In all instances, when the respondent says they would change behaviour, a move to another transport mode is the most popular choice. This perhaps emphasises how accessible Leppävaara is by public transport, as well as by walking and cycling connections.

However, when the dynamic price of parking drops, the proportion of respondents that would use public transport drops as well and other ways to change behaviour become more tempting.

It is interesting to compare the peak time scenarios because the respondent has options to park further away or travel later to avoid the highest parking fee. For shopping, travelling later is always more popular than parking further away. For social and work purposes however, parking further away is preferable.

When parking in zone A at both peak and off peak time, the respondent can either park in zone B and walk about 10 – 15 minutes to their final destination to reduce the parking fee or they can park outside of the dynamic parking scheme zone and walk about 30 minutes to their final destination in which they would avoid fees altogether. It is interesting to note that often, parking outside of both zones A and zones B and walking longer is preferable to paying a small fee and walking a shorter distance. This perhaps reinforces what Kalle Toiskallio mentioned in the interview in section 2.1, that people are prepared to walk significant distances to avoid parking fees.

7.2.3 Location analysis of scenario questions

Further to the analysis of willingness to pay for parking, an analysis was done on parking behaviour based on location. Those who live in Leppävaara are perhaps more willing to use other forms of transport because they are able to walk or take public transport more easily. On the other hand, they would be more affected by the parking fees. A comparison of behaviour between Leppävaara residents and non-Leppävaara residents is displayed in Figure 60. For this analysis Leppävaara residents were defined as the 125 people living within the 02600, 02660, and 02650 postcode areas, and non-Leppävaara residents were defined as the 141 participants from outside of these postcode areas. The reliability of these results is questionable, due to low response rates. Because of randomisation, each scenario question received about 70 responses on average. When this is further broken down into other categories this means that there may be only 35 responses per category. It is important to keep this in mind when examining these results.

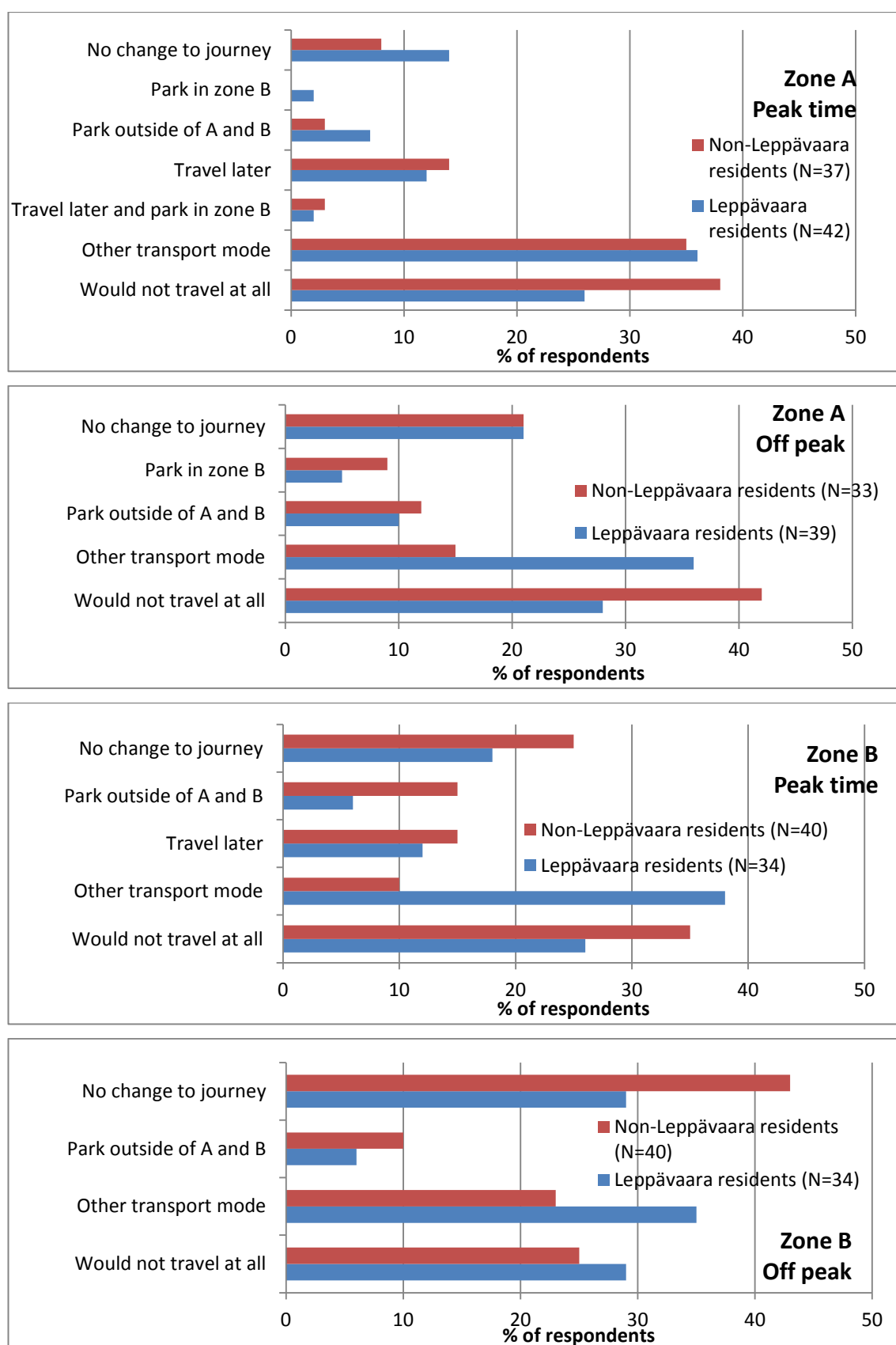


Figure 60. Changes in behaviour when visiting Leppävaara for shopping purposes for one hour under the dynamic parking scheme grouped by Leppävaara residents and non-Leppävaara residents

Because of the small sample size responding to this question, it is difficult to draw conclusions unless there is an obvious difference between answering. One pattern that seems to emerge, is that Leppävaara residents are more likely use another transport mode, which is understandable considering that the shops are within walking distance or probably reachable with a direct public transport connection. It is also true that Leppävaara residents are more likely to be familiar with the area's public transport timetables and the cost of a public transport ticket may be cheaper. For non-Leppävaara residents, distances are too large to consider walking, and public transport may involve making changes at some points of the journey.

The results suggest that when shopping in zone A at peak time, when they would be subject to a charge of 4€/hour, Leppävaara residents are more likely to make no change to journey than people from outside of Leppävaara. However, under different conditions, such as shopping in zone B at peak time and zone B at off peak time, Leppävaara residents are less likely to make no change to their journey. A possible explanation for this is that Leppävaara residents are used to shopping at the Sello shopping mall where the big supermarkets are located. They would like to travel by car because shopping trips often involve carrying heavy loads which are more difficult by other modes of transport. In zone B however, the shops are smaller and so a customer is less likely to buy several bags of groceries. This means that it is easier to transfer to other transport modes.

In most cases more non-Leppävaara residents say that they would not travel at all than Leppävaara residents. This is understandable, given that they can probably just as easily access an alternative shopping centre at a different location.

Comparison for work against location of resident is displayed in Figure 61.

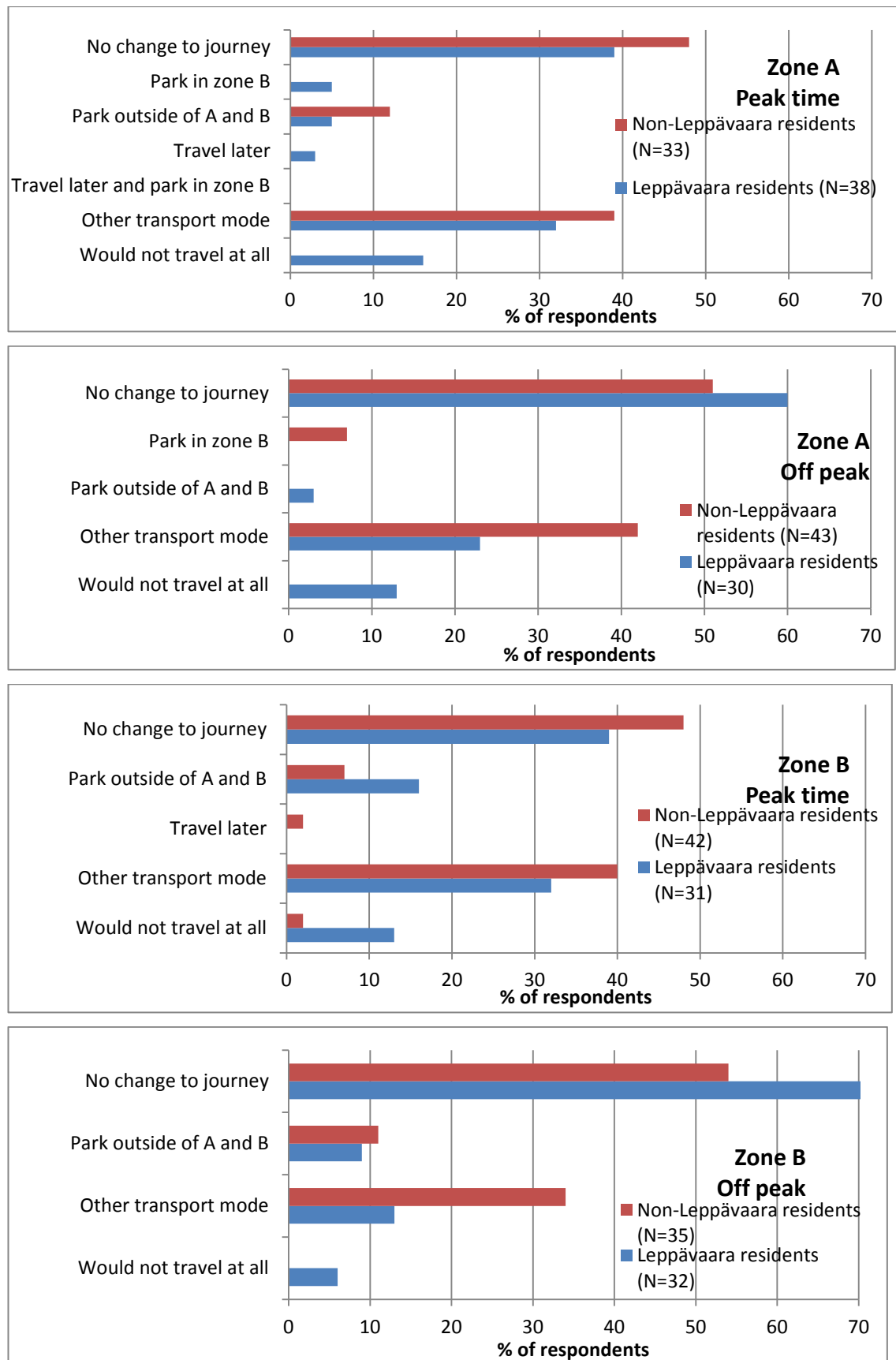


Figure 61. Changes in behaviour when visiting Leppävaara for work purposes for one hour under the dynamic parking scheme grouped by Leppävaara residents and non-Leppävaara residents

For work purposes, it is interesting that Leppävaara residents seem far more willing to not travel at all than non-Leppävaara residents. One possible explanation for this is strategic bias. Leppävaara residents would be more affected by parking fees and so they state they would not travel to the area in order to try and influence any future policy change.

In all cases, non-Leppävaara residents are more willing than residents to switch to another transport mode to access their destination. This may be coincidental produced by the unreliable low response rate and the presence of strategic bias amongst Leppävaara residents.

The comparison for social purposes against location of resident is displayed in Figure 62.

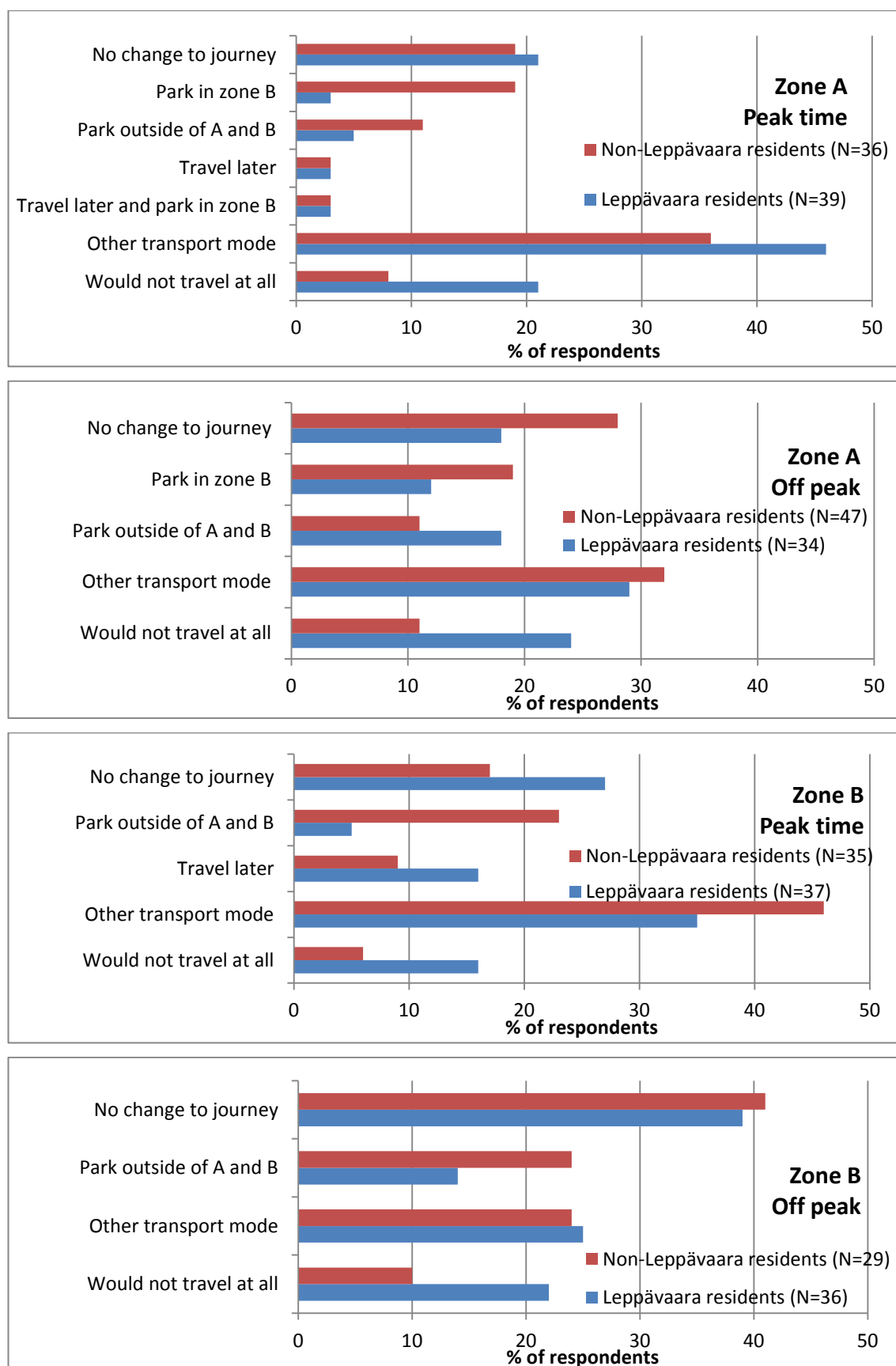


Figure 62. Changes in behaviour when visiting Leppävaara for social purposes for one hour under the dynamic parking scheme grouped by Leppävaara residents and non-Leppävaara residents

For social purposes, Leppävaara residents claim that they would be more likely not to make the trip than non-Leppävaara residents, if they had to pay for parking. This may be another example of strategic bias, and it may also be because Leppävaara residents are more likely to make social visits more often, meaning that they would have to pay the fees more regularly.

7.2.4 Analysis of scenarios by frequency of journey

To follow on from the analysis of behaviour according to location, it was decided to investigate behaviour according to how often the respondent visits Leppävaara. In this analysis, a regular visitor was defined as someone who visited Leppävaara for each respective purpose 1-3 times a week or more. Non-regular visitors were those who visited for each purpose a few times a month or less. The numbers of regular and non regular visitors for each category are as follows:

- Work – 54 regular visitors, 212 non-regular visitors
- Shopping – 155 regular visitors, 111 non-regular visitors
- Social – 155 regular visitors, 111 non-regular visitors

The regular visitor is more likely to have to pay for parking more often and so the difference between their change to behaviour and the non-regular visitor's change to behaviour is interesting to look into. This may again show instances of strategic bias. The results of the comparison for shopping purposes can be seen in Figure 63. Again, the reliability of these results is questionable, due to low response rates.

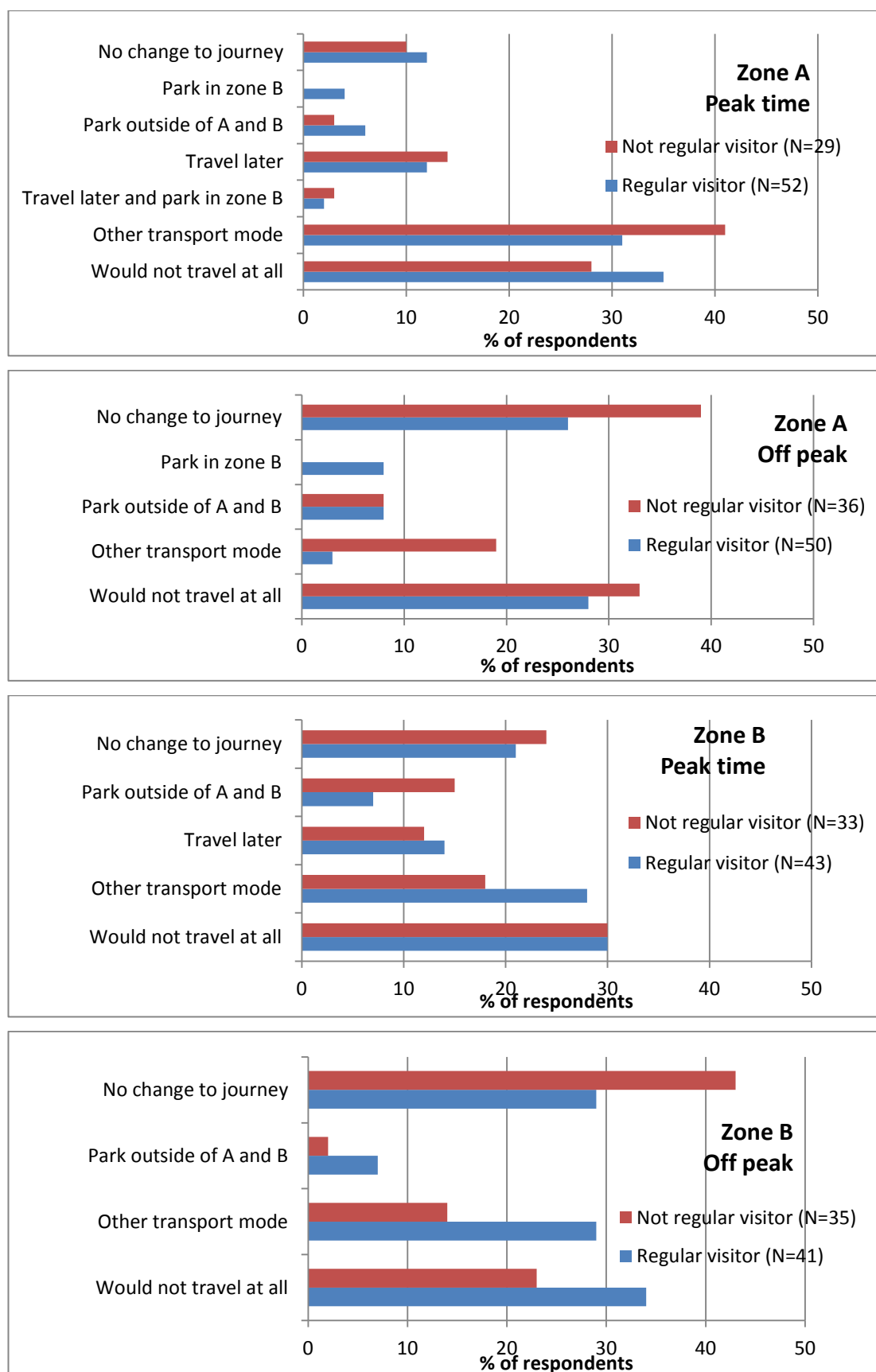


Figure 63. Changes in behaviour when visiting Leppävaara for shopping purposes for one hour under the dynamic parking scheme grouped by regular visitors to Leppävaara and non-regular visitors

Whilst there are few significant difference between responses, it is noticeable that those who are not regular visitors seem to be more likely to make no change to their journey and use the car. This might be because they are coming from further away, and do not have to pay the parking fee very often. Therefore, the sum they have to pay is not so significant on a monthly or yearly basis.

The comparison of regular visitors and non-regular visitors visiting Leppävaara for work purposes can be seen in Figure 64.

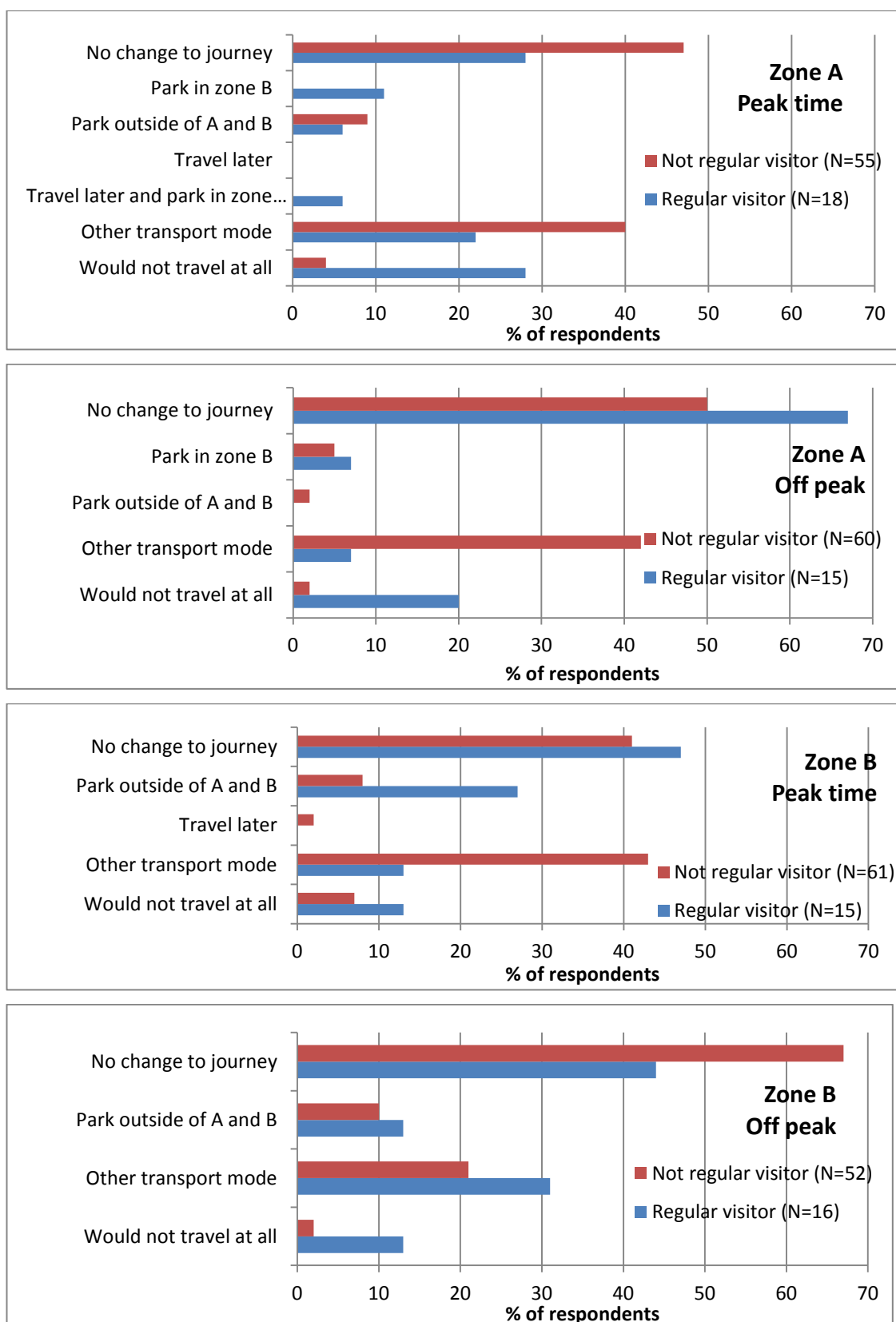


Figure 64. Changes in behaviour when visiting Leppävaara for work purposes for one hour under the dynamic parking scheme grouped by regular visitors to Leppävaara and non-regular visitors

Again, surprisingly, those who visit Leppävaara regularly for work are more likely to say that they would not travel at all if they had to pay for fees. This is surprising because normally there is not much choice when or where you have to travel for work purposes, and secondly the employer usually pays the fee so that the visitor is not adversely affected. Perhaps then, this is another example of strategic bias, with the regular visitors deliberately suggesting they would not travel to Leppävaara, in order to put off any potential policy change.

There also seems to be a pattern of non-regular visitors being more likely to switch to another transport mode than regular visitors. For non-regular visitors who are used to using the car, switching occasionally to a bus or train is perhaps more tolerable than it would be for the car user who visits Leppävaara more often and would have to make their switch to another transport mode permanent.

It is important to remember however, particularly with this set of results, that the response rate for regular visitors is particularly low, at between 15 and 20 responses. Reliability of these results therefore is questionable.

The comparison of regular visitors and non-regular visitors visiting Leppävaara for social purposes can be seen in Figure 65.

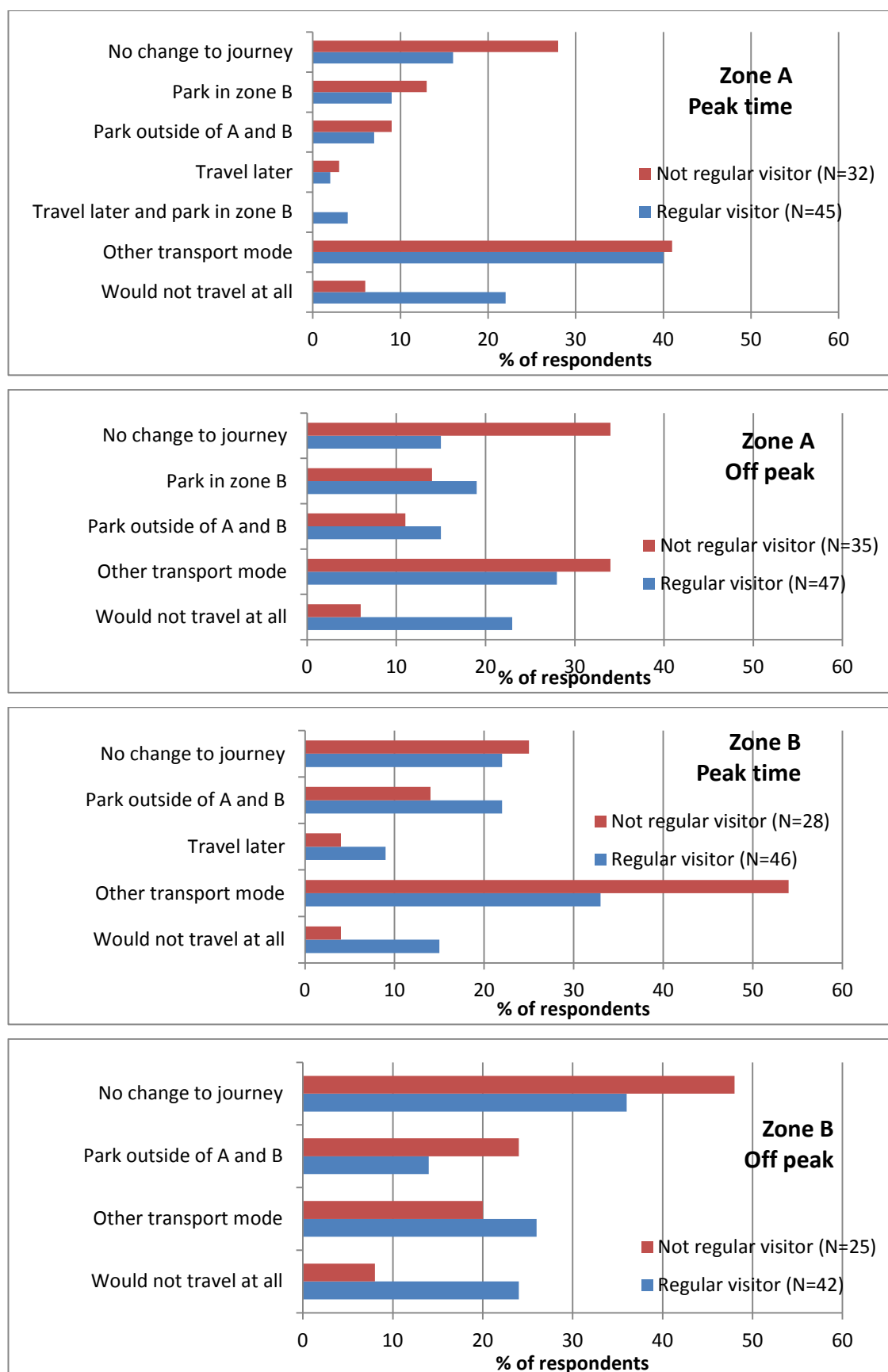


Figure 65. Changes in behaviour when visiting Leppävaara for social purposes for one hour under the dynamic parking scheme grouped by regular visitors to Leppävaara and non-regular visitors

Again, for social purposes the pattern of regular visitors being more likely than non-regular visitors to not travel to Leppävaara is repeated. The same explanations, such as strategic bias and the fact that they would suffer more from the fees are applicable here too.

7.3 Discussion

The results of the survey suggest that the public are broadly satisfied with parking in Leppävaara. This agrees with the results of the Transport Barometer research commissioned by the City of Espoo in 2012[54]. There appears to be a clear opposition to parking charges, although a notable proportion of respondents seem to agree that a fee of between 1-3€ is acceptable. In Leppävaara, most people prefer to park off-street than on-street which contrasts with results from a similar question asked as part of a survey in Helsinki in 2014 where most people said they preferred to park on-street. A possible explanation for this, is that in Helsinki the centralised off-street car parks are often situated further away from shops and services than the centralised off-street car parks in Leppävaara.

The stated preference scenario questions, which asked respondents to imagine a hypothetical situation and ponder how they would react to it, confirmed some expectations. People are less likely to adapt behaviour to avoid parking fees when visiting for shopping purposes, instead they are more likely to not travel to Leppävaara at all. The presence of other shopping centres that offer free parking is probably a big reason for this. If respondents do change their behaviour, switching to another transport mode is the most popular choice, followed by travelling later and then parking further away. It is no surprise that parking further away is the least popular option when changing behaviour because shopping often involves carrying heavy bags which is not very appealing over long distances.

For work purposes, it is clear that the fact that employers cover the cost of parking as part of travel expenses means that people are more willing to pay parking fees for work purposes.

When visiting for social reasons, the behaviour is slightly more complex. Fewer respondents said they would not travel at all when compared to those saying they would not travel at all to go shopping. One obvious reason for this when visiting somewhere to go shopping, there are plenty of alternative shopping centres nearby. For social reasons, more people are likely to make no change to journey. When they do change behaviour, using another transport mode is the most popular alternative, followed by parking further away and then parking later. For social visits, parking further away and walking to the destination is probably more manageable, because unlike shopping, it does not involve carrying heavy loads.

In terms of the dynamic parking scheme, in most cases parking in zone A at peak time, when the fee would have been 4€/hour produced the most amount of responses saying they would not travel at all, but this was not a particularly clear result. A more obvious pattern is the number of people who would make no change to the journey, and travel by car to their destination when parking in zone B at off peak time. This is when the parking fee would be 2€/hour which many felt was a more reasonable cost for parking.

The analysis of behaviour in the dynamic parking scheme by the home address of the respondent, and the frequency the respondent visits produced possible evidence of strategic bias. Although the response rates for these questions were low, there did seem to be a pattern of regular visitors, and Leppävaara residents showing stronger opposition to parking fees by claiming they would not travel to Leppävaara at all. In one way, this is a surprise, because they live in the area or visit regularly, which means they are more reliant on the services and social connections. However, it is also true that they would be more financially affected by parking fees, meaning that they would want to avoid paying them.

The closer analysis of the question regarding what respondents thought was a reasonable parking fee confirmed that income impacts upon the amount that people are willing to pay for parking. However, it is apparent that a more significant factor is the frequency that a person visits the area. Those who said they did not visit Leppävaara very often, were more likely to think that higher parking fees were more reasonable than those who visited Leppävaara regularly. This is not surprising, as those who visit regularly would

have to pay more for parking. Perhaps therefore, this question highlights an instance of strategic bias.

Efforts were made to avoid strategic bias by stressing that the research was undertaken with the Aalto University and not the City of Espoo. The Aalto University logo was used in the survey, and instructions stated that the purpose of the questionnaire was for University research. It seems that this message did work, but respondents were perhaps still conscious that the results may be of interest to officials at the City of Espoo. This is apparent through one of the comments received:

“I notice that the survey is not conducted by the City of Espoo, but I hope that the leaders get a summary of the results.”

Despite best efforts, it can probably be concluded therefore, that there is some element of strategic bias in the questionnaire results.

In terms of reliability, due to randomisation the scenario questions received fewer responses than other questions on the survey. The scenario questions are therefore less reliable, and only significant differences should really be taken into account. This is even more relevant when the scenario questions have been analysed by location and frequency of visit.

8 Conclusions

If the results of the survey suggest that the public are satisfied with parking in Leppävaara, and if that the analysis of parking spaces in Leppävaara also indicated that there are sufficient parking spaces for residents and that on street parking spaces can be used by short term visitors either for work or social reasons, it is worth answering a question presented in one of the comments from the survey, which was why are parking controls needed in Leppävaara at all.

Firstly, future demands and the pressure to increase growth in the area will mean that the parking resource becomes scarcer and should be used more efficiently. Whilst the parking supply is seen as satisfactory at the moment, this may not hold true in the future. New residential developments are being planned with reduced minimum parking requirements which will mean that more residents may find it harder to find a parking space for their car and they will be tempted to use on street parking.

There are also issues of equality. When interviewing Mika Rantala, one concern was that the service provided for residents by parking companies, in which residents pay a monthly fee for the right to use centralised off-street parking facilities, is being undermined by the presence of free on-street parking spaces nearby. A resident may not want to pay a monthly parking fee if they feel that they do not absolutely need to. This may mean that short term visitors, who have no other alternative than on-street parking facilities, suffer. In addition, Ali Lattunen brought to light the problem that uncontrolled parking is unfair in that there is a danger that they are only used by the person who gets there first. Parking controls can encourage a turnover so that many short term parkers are able to use the parking facility instead of one person parking for long term. Parking fees then can mean that on-street parking spaces can be used by a greater number of people, and people who really need the spaces (and are therefore willing to pay for the right to park).

Finally, amongst other aims, the new Transportation System Plan calls for more efficiency of the transport network and increased sustainability to aid development. This can be achieved through increasing turnover of parking spaces, encouraging the use of sustainable forms of transport, and reducing congestion at sensitive parts of the net-

work. These aims can all be achieved through parking fees, and a dynamic parking scheme can target congestion aims in particular.

In conjunction with the new Transportation System Plan, the City of Helsinki is actively pursuing the concept of mobility as a service, which if successful could be extended into the City of Espoo too. Although parking represents a small part of the mobility and transport network, nonetheless it can also be considered as a service, indeed Espoo's new parking policy document describes parking as such. Under the mobility as a service model, perhaps the monthly mobility package that the customer orders can include the right to park on-street for a certain number of hours.

Parking fees would bring additional benefits too. Although not thoroughly researched as part of this work, there is evidence to suggest that a new income stream could be opened up for the municipality which could be used to fund improved mobility infrastructure.

There is then, an argument for the introduction of parking fees in Leppävaara as well as other urban centres within the City of Espoo even though the public are satisfied with parking supply at present.

A dynamic scheme has more advantages. The parking analysis indicates that in zone A of the proposed parking scheme, the number of parking spaces per resident and per employee is much lower. Furthermore, accessibility within this zone is much higher. There is greater opportunity therefore, to use public transport or the cycling network to access the final destination in zone A. This can be further incentivised with the use of increased parking fees.

The advantage of the temporal variable in the dynamic parking scheme is that it can reduce congestion at sensitive times. Although there does not appear to be a congestion problem at present in Leppävaara, this may change in line with future population increases. In a truly dynamic parking scheme the temporal variable could change on a day to day basis. This means that at rare times when there is heavy congestion, such as at Christmas time, parking fees can increase to discourage car use.

Smart technology can be used to make the process of paying for fees more simple. In Helsinki it is possible to pay for parking using a mobile phone application, and the questionnaire results suggest that there is appetite for such a payment scheme in the City of Espoo as well.

One issue that became apparent in the survey was the perceived lack of enforcement. Time restrictions for parking are already operational in Leppävaara, but many suggest that they are not enforced. Furthermore, enforcement stops at 6pm which means that residents coming home from work are able to park on-street for the entire evening. It is possible with smart technology to improve and to extend the hours of enforcement through automation. In the City of Helsinki, parking controls are enforced until 9pm in the evening. For people who visit Leppävaara outside of the working day, such as those going to the shops, or those seeing friends, enforcement is needed at this time to ensure that there is a turnover of spaces so that they have opportunity to park on-street.

Smart technology enables greater enforcement and also improves the distribution of information. A dynamic parking scheme, that is purely based on demand and works on a complex level, with several geographical or temporal zones, can therefore be envisaged in the future. As part of this research, a simple model was proposed in order to gauge initial public reactions to such a scheme.

The questionnaire asked respondents to imagine how they would react if all parking spaces in Leppävaara were subject to a fee. Many people who shop in Leppävaara said they would go elsewhere because there is strong competition from other shopping malls within easy accessibility by car. It is unlikely therefore that the Sello shopping centre, for example would implement fees unless other shopping centres do so also. Furthermore, the vast majority of respondents said that they normally park off-street when visiting Leppävaara for shopping purposes. This means that should on-street parking fees be introduced, it is unlikely to affect people visiting Leppävaara for shopping purposes as they would use off-street parking facilities provided by the shopping malls.

People who visit Leppävaara for work reasons too would not be significantly affected by on-street parking fees. For reasons of competition, it is likely that businesses would want to keep their parking facilities free. In the analysis of parking spaces in

Leppävaara, in the whole area there are about 0.25 spaces per job, with 0.51 spaces per job in zone B of the dynamic parking scheme. Considering that in Helsinki the modal share of the private car transport is about 50% it can be assumed that in zone B at least, the number of parking spaces for work purposes is sufficient. In zone A there is benefit from the strong accessibility of the area. Perhaps most important however, is that for short term visitors, the employer would cover the cost of parking fees. Therefore on an individual level the impact parking fees would have on people visiting Leppävaara for work purposes, is small.

The impact upon residents was not taken into consideration in the survey because the survey examined short term parking only. However, from the parking analysis of Leppävaara there seems to be now an optimal amount of parking spaces for residential purposes. Nonetheless, there is evidence that residents park on street, perhaps because it is closer to their home or because they are not a customer of the Leppävaara parking company which entitles them to use a space in the off-street parking facilities. On-street parking fees would encourage residents to use off-street facilities that have been constructed for them. If there are still difficulties with residential parking, then perhaps a resident parking permit scheme can be investigated whereby a monthly fee entitles the permit holder the right to park on-street.

People visiting Leppävaara for social reasons seem to have the most difficulty finding a parking space and this was something that became apparent in the questionnaire. Visitors arrive after the working day, when enforcement of parking restrictions has stopped and when residents coming home from work are able to park on-street for the entire evening. Parking fees would help to generate turnover. This would mean that visitors have more opportunity to park, but they would have to pay for this privilege.

The dynamic parking scheme may lead to some parking in peripheral zones, although the proportion of people willing to do this seems to be small. An alternative impact of on-street parking fees would be that cruising for parking in private off-street parking facilities, such as the Sello shopping centre, may increase. This would in turn increase driver frustration which may encourage a move to a different transport mode. For the City of Espoo, it is not such a major concern if congestion and frustration happens on a private facility.

It is interesting to note that there is a significant proportion of respondents, about 90 people or 34% who said that between 1-4€/hour for parking is a reasonable cost. Although this is smaller than the approximately 160 respondents or 60% who say that parking should be between 0-1€/hour (and we can assume believe that parking should be free) when we take the evidence of strategic bias into account perhaps there is growing acceptance of parking fees. This is further reinforced in the questionnaire results, when willingness to travel to Leppävaara increases when the dynamic parking fee is between 2-3€/hour.

There are two examples where a dynamic parking scheme can help to encourage development. The first is in Leppävaara with the planning of a light rail line. The proposed route of the rail line removes parking spaces that are situated within zone A of the dynamic parking scheme. At present, planners are looking for alternative locations to relocate parking spaces lost to the development of the light rail. If dynamic parking fees are introduced, then perhaps it is not necessary to relocate the parking spaces because more people will use alternative modes of transport and so demand for parking may be reduced.

A second example can be found in the urban centre of Matinkylä. This area has a familiar profile to Leppävaara, in that like Leppävaara it has a transport interchange based on rail and bus lines (due to be opened in 2016), and a large shopping centre which provides many free parking spaces for its customers. In Matinkylä, there is a problem with large traffic volumes causing environmental problems which could possibly be an obstacle to development. The City of Espoo is planning a care home for the elderly in the centre of Matinkylä. It is hoped that a central location will mean those who live in the care home will not suffer from social exclusion. However, the proposed site of the care home is by a busy road and there are fears that the pollution caused by road traffic will be particularly harmful for elderly residents. An obvious solution to reduce road traffic would be through the implementation of parking fees that encourage the use of the more sustainable transport modes available. In this example however, a lot of the traffic on the road in question is generated by the shopping centre and so to reduce traffic volumes effectively, parking fees would have to be implemented together with the private owner of the shopping mall.

This leads to a final conclusion. Parking fees and a dynamic parking scheme can have positive benefits and can enable development. However, recalling the parking balance diagram in Figure 1 it is obvious that an effective parking scheme should include all available parking spaces, both public and private. If fees are implemented on public parking spaces only, then pressures on private parking spaces will be increased remarkably. And because of the high number of shopping malls and supermarkets within easy accessibility of motorists who live in the City of Espoo, a more regional strategy is required, although the complexities of the planning and negotiating such a scheme considering the number of stakeholders and competition interests would be very challenging.

9 Further research

Within the constraints of this research there were several factors that it was not possible to take into account.

In Finland, the climate is certainly worth consideration. Research undertaken by the City of Espoo has already found that people do not want to park on-street or outside during winter time when temperatures can drop to -20°C . This puts increased pressure on indoor parking facilities and would most probably influence the distance people are willing to walk to avoid parking charges in a dynamic parking scheme.

To keep the questionnaire short and simple, it was decided not to investigate the impact dynamic parking charges would have upon long term parking. There is evidence from the literature base to indicate that long-term parking would reduce if parking charges were implemented. However, under a dynamic parking scheme, the motorist has more alternatives and this research does not answer how people parking for long-term would react to avoid the fees. An expectation is that they would do more to avoid paying, and so there might be more willingness to park outside the zones or switch to public transport.

The question of long-term parking introduces the challenge of residential parking which was also not thoroughly considered in this research. Although the analysis seems to show that there are enough residential parking spaces, the opinions of the general public have not been investigated. Through the open comments section of the questionnaire there have been some complaints that it is difficult for residents to find a parking space in the evening. It is unclear however, what sort of parking space the resident is looking for, whether it should be in the immediate vicinity of the home address, whether it should be covered or uncovered, and what the resident would be willing to pay for this privilege.

Finally, the parking analysis and the estimation of parking spaces did not consider that throughout the day, the number of available spaces changes regularly. The large car park at the Sello shopping mall, with almost 3,000 parking spaces, is a popular resource for non-shoppers too. However the shopping mall closes in the evenings, and the impact that this sudden reduction on the parking supply has could deserve more attention.

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